SOIL SURVEY OF

Marshall County, South Dakota

United States Department of Agriculture
Soil Conservation Service
and
United States Department of the Interior
Bureau of Indian Affairs
In cooperation with
South Dakota Agricultural Experiment Station

Major fieldwork for this soil survey was done in the period 1961–69. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county at the time the survey was in progress. This survey was made cooperatively by the Soil Conservation Service, the South Dakota Agricultural Experiment Station, and the Bureau of Indian Affairs. It is part of the technical assistance furnished to the Marshall County Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Marshall County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the windbreak group, pasture group, and range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the pasture groups, the range sites, and the windbreak groups.

Foresters and others can refer to the section "Use of the Soils for Windbreaks," where the soils of the county are grouped according to their suitability for trees and shrubs in windbreaks.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the section "Town and Country Planning."

Engineers, builders, and community planners can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Marshall County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: **Contour stripcropping on an area of Poinsett-Forman complex, 2 to 6 percent slopes.**

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SOIL SURVEY OF MARSHALL COUNTY, SOUTH DAKOTA

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SOILS SURVEYED BY EDGAR H. ENSZ, MERLE M. KOST, KENNETH F. MILLER, AND LYLE D. PASCHKE, SOIL CONSERVATION SERVICE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, IN COOPERATION WITH THE SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

MARSHALL COUNTY is in the northeastern part of South Dakota (fig. 1). The northern county line is part of the State line between North Dakota and South Dakota. The county has an area of about 542,784 acres, excluding areas of open water more than 40 acres in size. Britton, in the west-central part of the county, is the county seat and the largest town. Other towns are Amherst, Eden, Kidder, Lake City, Langford, and Veblen.

The county is at the northern extremity of the Coteau des Prairies, a highland plateau shaped like a flatiron. This plateau is a conspicuous landscape in Marshall County as well as in the eastern part of South Dakota. Except for the extreme northeast corner of the county, the eastern two-thirds of the county is on the Coteau des Prairies, known locally as "Sisseton Hills." The extreme northeast corner is part of the Minnesota River-Red River lowlands. The western part of the county is on the Lake Dakota Plain.

The Lake Dakota Plain is mostly nearly level, but the Prairie Coteau is mostly gently undulating to hilly. The Continental Divide extends east and west through the northern part of the county on a line through the town of Britton. South of this line the county drains to the Gulf of Mexico, and north of it, it drains northward to the Hudson Bay. The elevation at Britton is 1,352 feet.

About 66 percent of the county is cropland, and about 30 percent is in native grass. Spring wheat, corn, oats, flax, barley, and alfalfa are the main crops. Farming is diversified. Livestock and livestock products are the main sources of farm income, but income from cash crops also is important.

[1] Others who contributed to the soil survey are GEORGE W. ANDERSON, WILLIAM G. GLOVER, A. R. GOERDEL, VERNON F. KOOPMAN, and WILLIAM J. MCCARTY, Soil Conservation Service.

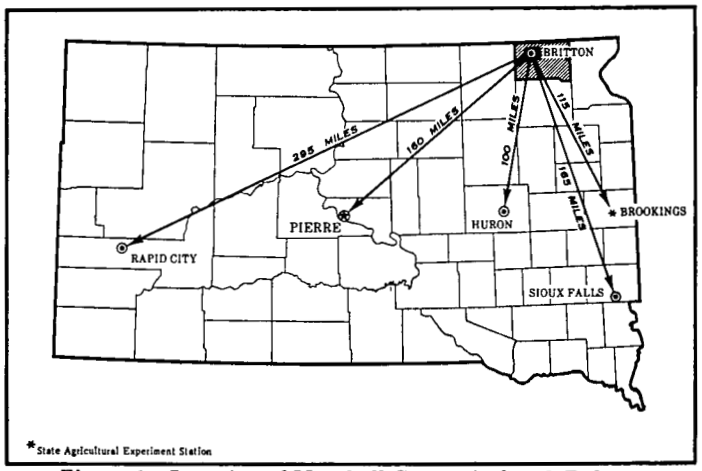

Figure 1.—Location of Marshall County in South Dakota.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Marshall County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different textures in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Beotia and Forman, for example, are the names of two soil series. All the soils in the United States having the same series

name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Kranzburg silt loam, 0 to 2 percent slopes, is one of several phases within the Kranzburg series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Marshall County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Serden-Venlo complex, 0 to 6 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Benoit and Divide loams is an undifferentiated soil group in this county.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severly eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Sandy lake beaches is a land type in this county.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Marshall County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil association names and delineations shown on the general soil map do not fully agree with those shown on published maps for adjacent counties. Differences are the result of better knowledge of soils, of changes in concepts of soil series and in the application of the soil classification system, of intensity of mapping, and of the extent of soils within the survey.

The soil associations in this survey have been grouped into five general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the following pages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1 the word "sandy" refers to the texture of the surface layer.

Excessively Drained to Somewhat Poorly Drained Soils Formed Mainly in Lacustrine Material; on Glacial Lake Plains

The soils in this group formed mainly in lacustrine deposits that range from sand to silty clay. In many places the sandy deposits have been reworked and redeposited by wind. Most of the more level loamy and silty soils are used for crops. The very sandy soils and the more poorly drained soils are in grass and are used mainly for grazing, hay, and wildlife habitat. Concerns of management range from wetness in the more poorly drained areas to soil blowing in drier areas.

1. Maddock-Serden association

Nearly level to hilly, well-drained to excessively drained, sandy soils formed in eolian and lacustrine sand

This association consists mainly of gently undulating to rolling soils, but a few hilly areas are in parts of the association where the action of wind has shifted the sands into dunelike relief. Differences in elevation are as much as 30 feet in the hilly areas. Slopes are short and well rounded. Drainage patterns are poorly defined.

This association covers about 1 percent of the county. Maddock soils make up about 45 percent of the association, Serden soils about 25 percent, and minor soils 30 percent.

Maddock soils are gently undulating to rolling (fig. 2) and are well drained. They have a surface layer of dark-gray loamy fine sand that is underlain by a transitional layer of grayish-brown loamy fine sand. The underlying material is light brownish-gray fine sand.

Serden soils are nearly level to hilly and are excessively drained. They are lighter colored than Maddock soils and are fine sand throughout.

Among the minor soils are the nearly level Embden and Hecla soils on rises and the Hamar, Ulen, and Venlo soils in swales and depressions.

Fertility is medium to low in the major soils in this association, and the soils are droughty. The loose sandy soils blow easily if the vegetative cover is removed. The main concern of management is controlling soil blowing.

Most of this association is in native grass and is used for pasture. Small areas are cultivated, mainly to provide feed and forage crops for livestock. Production of beef cattle is the main enterprise in this association.

2. Embden-Hecla-Ulen association

Nearly level to gently undulating, well-drained to somewhat poorly drained, loamy and sandy soils formed in eolian, lacustrine, and outwash sand

This association consists of relatively flat soils that are marked by many very gentle and gentle undulations interspersed with slight depressions (fig. 3). Slopes are short and well rounded. A few small lakes are in the area, and some of the low areas are marshy. Drainage patterns are poorly defined.

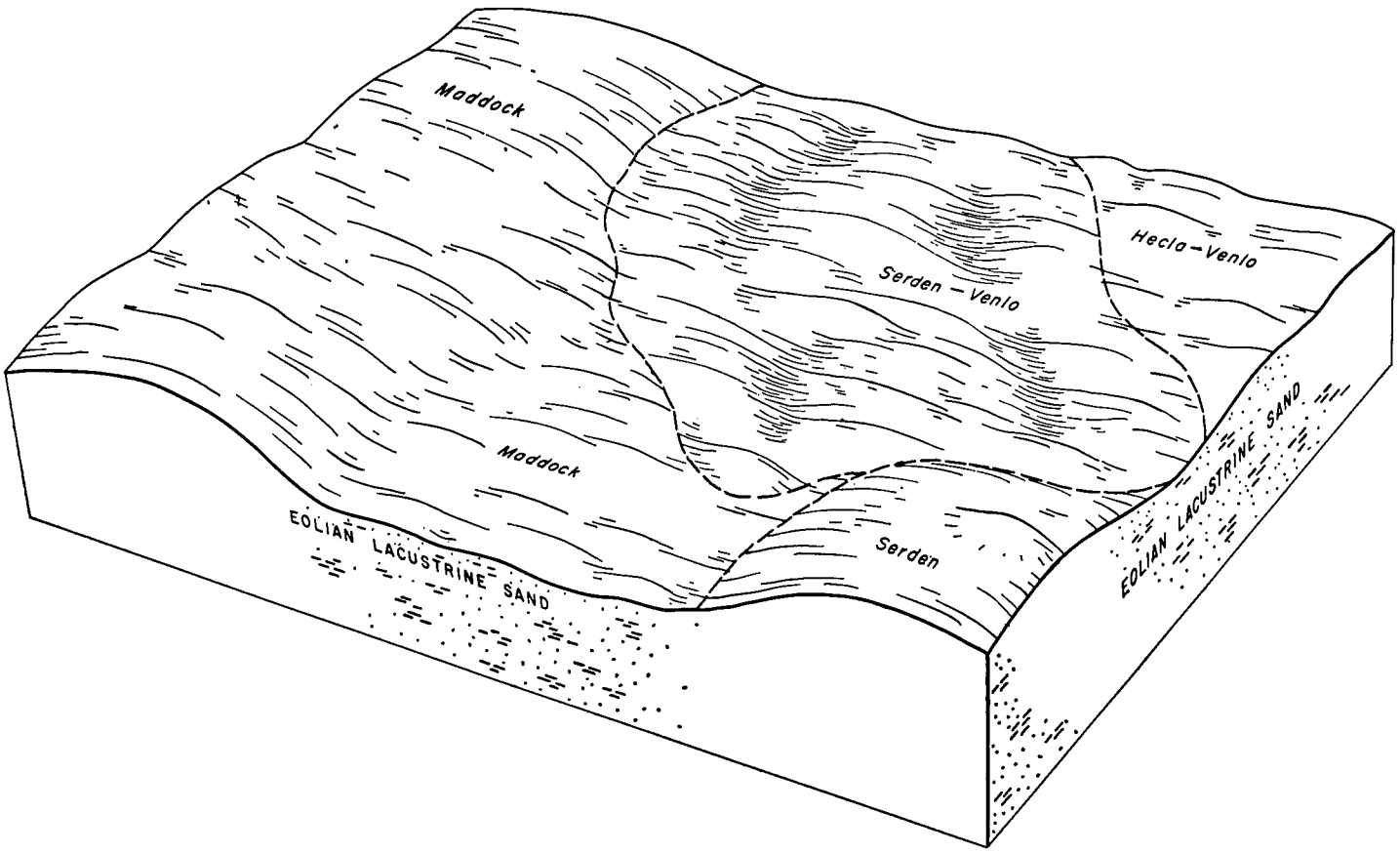

***Figure 2.*—Relative position of soils in the Maddock-Serden association.**

Figure 3.—**Aerial view of an area of Embden-Hecla-Ulen association.**

This association covers about 11 percent of the county. Embden, Hecla, and Ulen soils each make up about 20 percent of the association. Minor soils make up the remaining 40 percent.

Embden soils commonly are on the higher parts of the landscape and are well drained to moderately well drained. They have a surface layer of dark-gray and dark grayish-brown fine sandy loam and a subsoil of grayish-brown fine sandy loam. The underlying material is pale-brown loamy fine sand and fine sandy loam.

Hecla soils are on slight rises and are moderately well drained. They have a thick surface layer of dark-gray loamy fine sand that is underlain by a transitional layer of grayish-brown loamy fine sand. The underlying material is light-gray fine sand.

Ulen soils are mostly nearly level and are moderately well drained to somewhat poorly drained. These calcareous soils have a surface layer of dark-gray fine sandy loam that is underlain by a transitional layer of gray fine sandy loam. Loamy fine sand is below a depth of 24 inches.

Among the minor soils are Arveson and Hamar soils in swales and depressions, Larson and Swenoda soils in areas underlain by silty materials, and Stirum soils intermingled with Ulen soils.

Fertility is medium to low in the soils in this association, and the Ulen soils are high in content of lime. The water table fluctuates between depths of 3 and 10 feet in areas of Hecla and Ulen soils and seasonably rises higher in areas of some of the minor soils. Controlling soil blowing is the main concern of management.

Areas of this association are used for crops, hay, and pasture. Corn, barley, rye, alfalfa, and tame grasses are the main crops. Diversified farming that emphasizes livestock feeding is the main enterprise in this association.

3. *Beotia-Great Bend association*

Nearly level to sloping, well-drained, silty soils formed in lacustrine silt

This association consists mostly of nearly level to gently sloping soils. Slopes are long and smooth. Small depressions and broad flats are scattered throughout the area.

This association covers about 15 percent of the county. Beotia soils make up about 45 percent of the association, Great Bend soils about 10 percent, and minor soils the remaining 45 percent.

Beotia soils are nearly level to gently sloping. They have a surface layer of dark-gray silt loam. The upper part of the subsoil is dark-gray and dark grayish-brown silt loam. The lower part of the subsoil and the underlying material are calcareous, light brownish-gray and light-gray silt loam.

Great Bend soils are nearly level to sloping. They commonly are at higher elevation than Beotia soils and are calcareous at a shallower depth. They have a surface layer of dark-gray silt loam and a subsoil of dark-gray and grayish-brown silt loam. The underlying material, at a depth of 14 inches, is calcareous, light-gray silt loam.

Among the minor soils are Aberdeen and Harmony soils in the more level areas, Bearden soils on flats around depressions or potholes, Lamoure soils on bottom lands along the larger drainageways, Tonka soils in depressions, and Zell soils on the tops and upper sides of ridges and knolls.

Fertility is medium to high in the major soils of this association, and these soils are easy to work. Available water capacity is high. Conserving moisture and controlling erosion and soil blowing are the main concerns of management.

Most of these soils are used for crops. Corn, wheat, barley, oats, and alfalfa are the main crops. Small areas are in native and tame pasture. Diversified farming that emphasizes livestock farming is the main enterprise in this association.

4. *Harmony-Aberdeen-Exline association*

Nearly level, moderately well drained to somewhat poorly drained, silty soils formed in lacustrine silt and silty clay

This broad association is flat in appearance. The soils are nearly level. Differences in elevation are less than 6 feet. Many broad flats are in the area. The drainage pattern is poorly defined, and flow of water in drainageways is sluggish.

This association covers about 8 percent of the county. Harmony soils make up about 35 percent of the association, Aberdeen soils 30 percent, Exline soils 15 percent and minor soils about 20 percent.

Harmony soils are on very slight rises and are moderately well drained. They have a surface layer of dark-gray silty clay loam. The upper part of the subsoil is gray and grayish-brown silty clay, and the lower part is calcareous, grayish-brown silty clay loam. The underlying material is calcareous, light-gray silty clay loam.

Aberdeen soils are in flat areas and are moderately well drained to somewhat poorly drained. They have a surface layer of dark-gray silty clay loam that is underlain by a layer of gray silty clay loam. The upper part of the subsoil is dark-gray and grayish-brown silty clay. The lower

part is calcareous, grayish-brown silty clay loam that contains nests of salts. The underlying material is calcareous silty clay loam that has mottled colors.

Spots of Exline soils are in depressions within areas of Aberdeen soils. These soils (fig. 4) are somewhat poorly drained. They have a thin surface layer of dark-gray silt loam and a thin subsurface layer of gray silt loam. The claypan subsoil, at a depth of 4 inches, is dark-gray silty clay in the upper part and grayish-brown silty clay in the lower part. The lower part of the subsoil and the calcareous underlying silty clay are high in salts.

Among the minor soils are well-drained Beotia and Great Bend soils on rises, Bearden soils in flat areas around potholes and depressions, Colvin soils in swales and depressions, and Tonka soils in potholes.

Fertility ranges from medium to low in the major soils in this association. Available water capacity ranges from low in the Exline soil to high in the Harmony soil. The Aberdeen and Exline soils take in water slowly and release moisture slowly to plants. The soils are slow to dry out, and seeding is delayed some years. Maintaining tilth and improving water intake are the concerns of management.

Most of this association is used for crops. Wheat, barley, oats, corn, and alfalfa are the main crops. Some areas are in native and tame grasses and are used for hay or pasture. Small-grain crops are a major source of cash income in this association, and diversified farming is the main enterprise.

Well-drained Soils Formed in Loess, Glacial Drift, and Lacustrine Material; on Uplands

Most of the soils in these associations are silty, but some are loamy and others are clayey. Most of the soils are cultivated. Controlling erosion is the main concern of management on these well-drained soils.

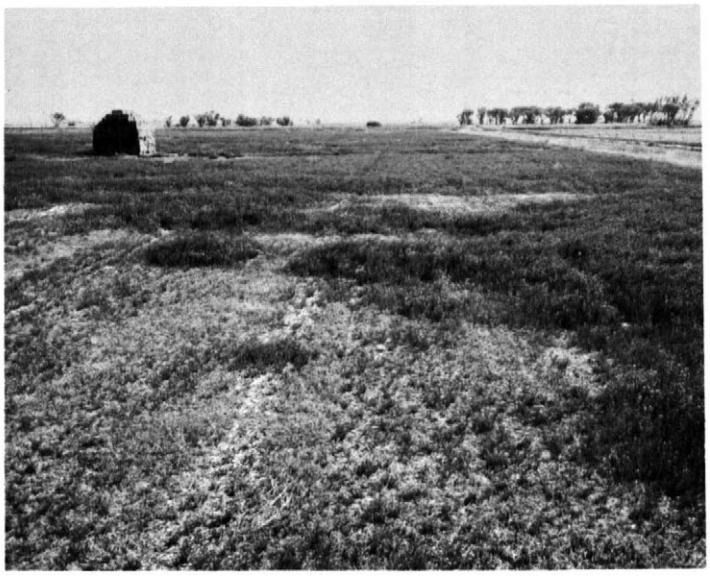

Figure 4.—Exline soils in depressions within areas of Aberdeen soils in the Harmony-Aberdeen-Exline association.

5. Kranzburg association

Nearly level to sloping, well-drained, silty soils formed in loess over glacial till

This association consists of an upland plateau or benchlike area above the Harmony-Aberdeen-Exline association to the west, but below the Forman-Aastad-Buse association to the east. Slopes are long and uniform. Many drainageways cross the area, and the drainage pattern is well defined.

This association covers about 7 percent of the county. Kranzburg soils make up about 60 percent of the association and minor soils about 40 percent.

Kranzburg soils have a surface layer of dark-gray silt loam and a subsoil of dark grayish-brown and grayish-brown silt loam. The underlying material, to a depth of 26 inches, is calcareous, light brownish-gray silt loam. Below this is clay loam glacial till that is calcareous.

Among the minor soils are Aastad soils in swales, Buse and Forman soils on sides of drainageways where the silty loess thins out over the glacial till, Edgeley soils in areas where the underlying material is shaly till and bedded shale, Estelline soils in areas where the underlying material is sand and gravel, and Kloten soils on the sides of deeply entrenched draws. Also, areas of Loamy alluvial land are on narrow bottom lands along drainageways.

Fertility is medium to high in soils in this association. These soils take in water readily and have high available water capacity. Conserving moisture, controlling erosion, and maintaining fertility are the main concerns of management.

Most areas of this association are used for crops. Corn, wheat, barley, oats, and alfalfa are the main crops. Areas of steeper soils along drainageways are in native grass and are used for grazing. The sale of small grain and livestock are major sources of farm income. Diversified farming is the main enterprise.

6. Forman-Poinsett association

Nearly level to rolling, well-drained, loamy and silty soils formed in glacial drift

This association consists of gently undulating to rolling soils (fig. 5). Most slopes are relatively short and well rounded. Many lakes, sloughs, and closed depressions dot the landscape. Drainageways commonly terminate in these low areas.

This association covers about 13 percent of the county. Forman soils make up about 30 percent of the association and Poinsett soils 15 percent. The remaining 55 percent is made up of lakes, sloughs, and minor soils.

Forman soils are gently undulating to rolling. They have a surface layer of dark-gray loam. The upper part of the subsoil is dark-gray and very dark grayish-brown loam, and the lower part is brown clay loam. The underlying material is clay loam glacial till or glacial drift stratified with loamy material.

Poinsett soils are nearly level to rolling. They have longer and smoother slopes than Forman soils. The surface layer is dark-gray silt loam. The subsoil is dark-gray and dark grayish-brown silty clay loam in the upper part and pale-brown, calcareous silty clay loam in the

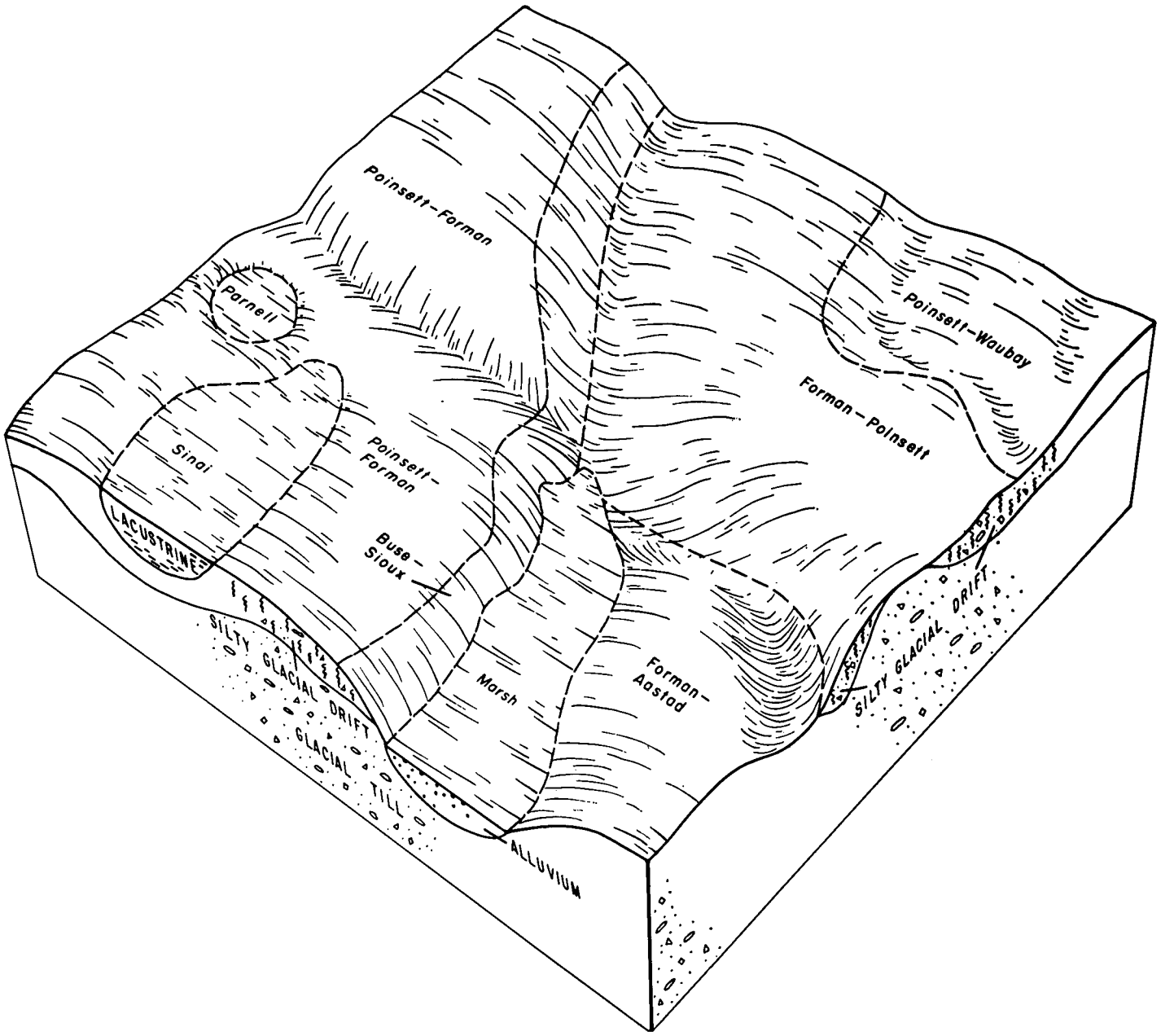

Figure 5.—**Relative position of soils in the Forman-Poinsett association.**

lower part. The underlying material is calcareous silty clay loam stratified with sandy loam.

Among the minor soils are Aastad and Waubay soils in swales; Buse soils on ridges, knolls, and sides of entrenched drainageways, sloughs, and lakes; Fordville, Renshaw, and Sioux soils in areas where the underlying material is sand and gravel; Parnell soils in potholes or closed depressions; and Sinai soils on high benches or flattened hilltops. Also, areas of Marsh and many lakes, including Roy Lake and Clear Lake, are in this association.

Fertility is medium to high in the soils of this association. Available water capacity is high. Controlling erosion is the main concern of management.

Most of this association is used for crops and pasture. Wheat, corn, flax, alfalfa, and tame grasses are the main crops. Some of the steeper soils and the poorly drained soils in depressions are used for hay and pasture. Diversified farming is the main enterprise in this association.

7. *Sinai-Poinsett association*

Nearly level to sloping, well-drained, clayey and silty soils formed in lacustrine sediment and glacial drift

This association consists of a high, benchlike plateau on uplands. The soils are mostly nearly level to gently sloping. Slopes are long and uniform. The drainage pattern is fairly well defined.

This association covers less than 1 percent of the county. Sinai soils make up about 70 percent of the association, Poinsett soils 20 percent, and minor soils 10 percent.

Sinai soils are on the higher terrain and its side slopes. They have a surface layer of dark-gray silty clay and a subsoil of silty clay that is dark gray in the upper part and is grayish brown and calcareous in the lower part. The underlying material is calcareous, light-gray silty clay and silty clay loam.

Poinsett soils have a surface layer of dark-gray silt loam. The subsoil is silty clay loam that is dark gray and dark grayish brown in the upper part and pale brown and calcareous in the lower part. It is underlain by calcareous silty clay loam that is stratified with sandy loam.

Among the minor soils are poorly drained Dovray soils in low areas, Forman soils in areas of Poinsett soils, and Parnell soils in depressions or potholes.

Fertility is medium to high in the soils of this association. Available water capacity is high. The Sinai soils take in water slowly and are slow to dry out. Tilth deteriorates in Sinai soils if they are cultivated when wet. Maintaining tilth, conserving moisture, and controlling erosion are the main concerns of management.

Most of this association is cultivated. Flax, wheat, barley, corn, and alfalfa are the main crops. A few small areas are in native grass. The sale of small grain provides the major source of income. Diversified farming is the main enterprise.

Well-drained to Poorly Drained Soils Formed in Glacial Till; on Uplands

In this group are loamy and silty soils that formed in glacial till. Slopes are mostly short and irregular. Many lakes, sloughs, and potholes are in the area. Areas of nearly level to sloping soils are cultivated, but areas of rolling to steep soils are mainly in native grass and are used for pasture and hay. Controlling erosion and conserving moisture are the concerns of management.

8. Forman-Aastad-Buse association

Nearly level to steep, well drained and moderately well drained, loamy soils formed in glacial till

This association is part of a glacial moraine known locally as the "Sisseton Hills." The soils are nearly level to hilly, and slopes are irregular and convex. Lakes, sloughs, and closed depressions or potholes dot the landscape. The drainage pattern is poorly defined in much of the area, but the pattern is more distinct in the rolling to steep soils on the outer edges where deeply entrenched drainageways route water to lower lying, adjacent associations.

This association covers about 36 percent of the county. Forman soils make up about 35 percent of the association (fig. 6), Aastad soils about 10 percent, Buse soils about 10 percent, and minor soils the remaining 45 percent.

Forman soils are nearly level to hilly and are well drained. They have a surface layer of dark-gray loam. The upper part of the subsoil is dark-gray and very dark grayish-brown loam, and the lower part is brown clay loam. The underlying material is calcareous clay loam.

Aastad soils are in swales and are moderately well drained. They have a thick surface layer of dark-gray loam and a subsoil of dark-gray and grayish-brown clay loam. The underlying material is calcareous, light brownish-gray and light-gray clay loam.

Buse soils are undulating to steep and are well drained. They have a thin surface layer of dark-gray loam that is underlain by a transitional layer of calcareous, dark grayish-brown and grayish-brown clay loam. Below a depth of 8 inches is calcareous, light brownish-gray and light-gray clay loam.

Among the minor soils are Fordville, Renshaw, and Sioux soils in small areas underlain by gravel; Oldham and Parnell soils in depressions and potholes; Peever soils on rises along with Forman soils; Sieche soils on the sides of deeply entrenched draws and coulees; and Vallers soils in low areas adjacent to potholes. Also, small lakes and areas of Marsh are in some of the depressions and potholes.

Forman and Aastad soils are easy to work and are medium to high in fertility. They have high available water capacity. Buse soils are medium to low in fertility. They are stony in places and are unsuited to cultivation because of the erosion hazard. Controlling erosion and conserving moisture are the main concerns of management. Mechanical control of erosion is difficult because of the short, irregular slopes and the presence of many small potholes, sloughs, and lakes. Cobblestones and other stones hamper tillage in some fields.

Slightly more than half of the association is used for crops and tame pasture. Wheat, corn, flax, alfalfa, and tame grasses are the main crops. The rest of the area is in native grass and is used for pasture and hay. Livestock farming is the main enterprise in this association.

9. Peever-Forman-Tonka association

Nearly level to sloping, well-drained, loamy soils formed in glacial till and level, poorly drained, silty soils formed in alluvium from adjacent uplands

This association consists of areas on foot slopes below the Sisseton Hills (fig. 7). The soils are mostly nearly level to sloping, but narrow areas of steeper soils are along some of the drainageways in which water flows out of Sisseton Hills and through the association. Many small potholes are scattered throughout the areas.

This association covers about 2 percent of the county. Peever soils make up about 65 percent of the association, Forman soils 15 percent, Tonka soils 10 percent, and minor soils 10 percent.

Peever soils are nearly level to sloping. Many slopes are long and smooth. They have a surface layer of dark-gray clay loam. The upper part of the subsoil is dark-gray to grayish-brown heavy clay loam, and the lower part is calcareous, grayish-brown clay loam. The underlying material, below a depth of 24 inches, is calcareous, light brownish-gray clay loam.

Forman soils are nearly level to undulating. Slopes are shorter and more rounded than those of Peever soils.

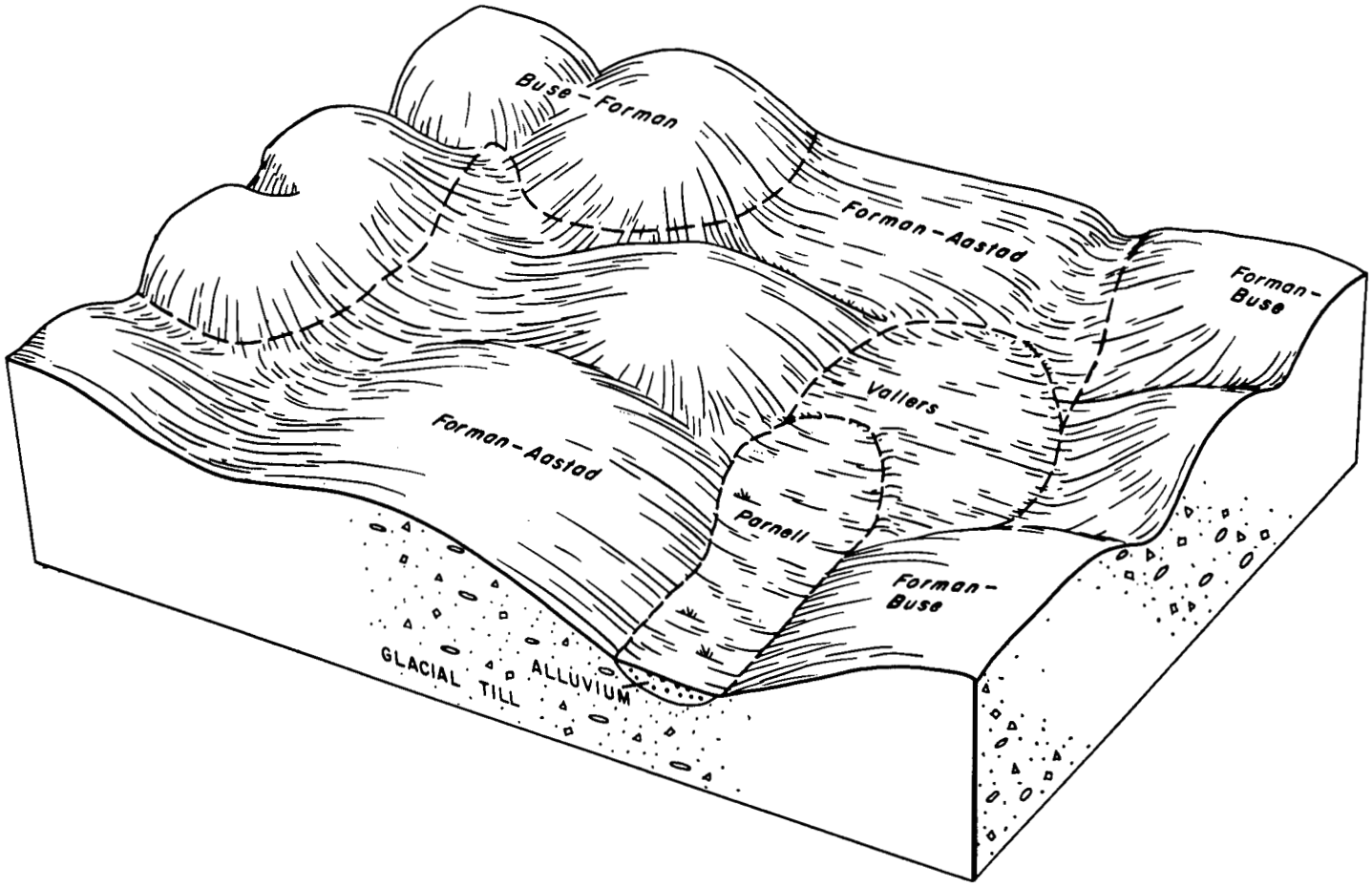

Figure 6.—**Relative position of soils in the Forman-Aastad-Buse association.**

The Forman soils have a surface layer of dark-gray loam. The upper part of the subsoil is dark-gray and very dark grayish-brown loam, and the lower part is brown clay loam. The underlying material is calcareous clay loam.

Tonka soils are in closed depressions or potholes. They have a surface layer of dark-gray silt loam and a subsurface layer of gray silt loam. The subsoil, to a depth of 40 inches, is gray silty clay loam and silty clay. The underlying material is light brownish-gray silty clay loam.

Among the minor soils are Aastad soils in swales, Buse soils on the sides of entrenched drainageways, Dovray and Lamoure soils on bottom lands, Hamerly soils on areas adjacent to closed depressions, and Fordville and Renshaw soils in areas underlain by sand and gravel.

Fertility is medium to high in the soils of this association. Available water capacity is moderate to high. The Peever soil takes in water slowly and loses its tilth if cultivated when wet. Maintaining tilth, controlling erosion, and conserving moisture are the main concerns of management.

Most of this association is used for crops. The soils are suited to all crops commonly grown in the county. Small areas are used for tame pasture or native range. The sale of small grain is a major source of income. Diversified farming is the main enterprise.

Well-drained to Excessively Drained Soils Formed in Glacial Outwash; on Uplands

In this group are loamy soils underlain by sand and gravel. The gently sloping areas are cultivated, but the soils are somewhat droughty. The rolling to steep areas are mainly in native grass. Conserving moisture and controlling erosion and soil blowing are concerns of management.

10. Renshaw-Fordville-Sioux association

Nearly level to steep, well-drained to excessively drained, loamy soils underlain by sand and gravel

This association consists of glacial outwash plains and glacial moraines. The soils are nearly level to steep. Slopes are short and well rounded in the steeper parts of the association but are longer and smoother in the nearly level areas. Several lakes, including Piyas and Buffalo Lakes, are in this association.

This association covers about 4 percent of the county. Renshaw soils make up about 25 percent of the association (fig. 8), Fordville soils 15 percent, Sioux soils 15 percent, and minor soils 45 percent.

Renshaw soils are nearly level to undulating and are well drained. They have a surface layer of dark-gray loam and a subsoil of dark grayish-brown loam. Calcareous sand and gravel are at a depth of 17 inches.

Figure 7.—**Aerial view of an area of Peever-Forman-Tonka association below the Sisseton Hills.**

Fordville soils are similar to Renshaw soils but are deeper over sand and gravel. They have a surface layer of dark-gray loam and a subsoil of loam. Sand and gravel are at a depth of 25 inches.

Sioux soils are rolling to steep and are excessively drained. They have a thin surface layer of dark-gray loam that is underlain by a transitional layer of calcareous, grayish-brown gravelly loam. Calcareous sand and gravel are at a depth of 8 inches.

Among the minor soils are Arvilla soils intermingled with Sioux soils, Benoit and Divide soils on broad flats, Buse and Forman soils in areas underlain by glacial till, and Parnell soils in some of the potholes. Also, areas of Marsh are in some of the depressions.

The soils in this association are droughty. Conserving moisture and controlling erosion and soil blowing are the main concerns of management.

Much of this association is in native grass and is used for pasture and hay. Fordville and Renshaw soils are suitable for irrigation. Flax, wheat, oats, and alfalfa are the main crops in cultivated areas. The Sioux soils are not suited to cultivation. Livestock farming is the main enterprise in this association.

Somewhat Poorly Drained to Poorly Drained Soils Formed in Alluvium; on Bottom Lands

In this group are clayey and silty soils that are level and nearly level. Farming operations commonly are delayed by wetness, but many areas are cultivated. Wetness, maintaining tilth, and improving water intake rates are concerns of management.

11. Dovray-Ludden-Lamoure association

Level and nearly level, poorly drained to somewhat poorly drained, clayey and silty soils formed in alluvium

This association consists of broad flats (fig. 9) along drainageways in the northeastern part of the county. Differences in elevation are less than 5 feet.

This association covers about 2 percent of the county. Dovray soils make up about 55 percent of the area, Ludden soils 30 percent, Lamoure soils 10 percent, and minor soils 5 percent.

Dovray soils are poorly drained. They have a very thick surface layer of dark-gray silty clay and a subsoil of calcareous, dark-gray clay. Below a depth of 32 inches is calcareous, gray silty clay.

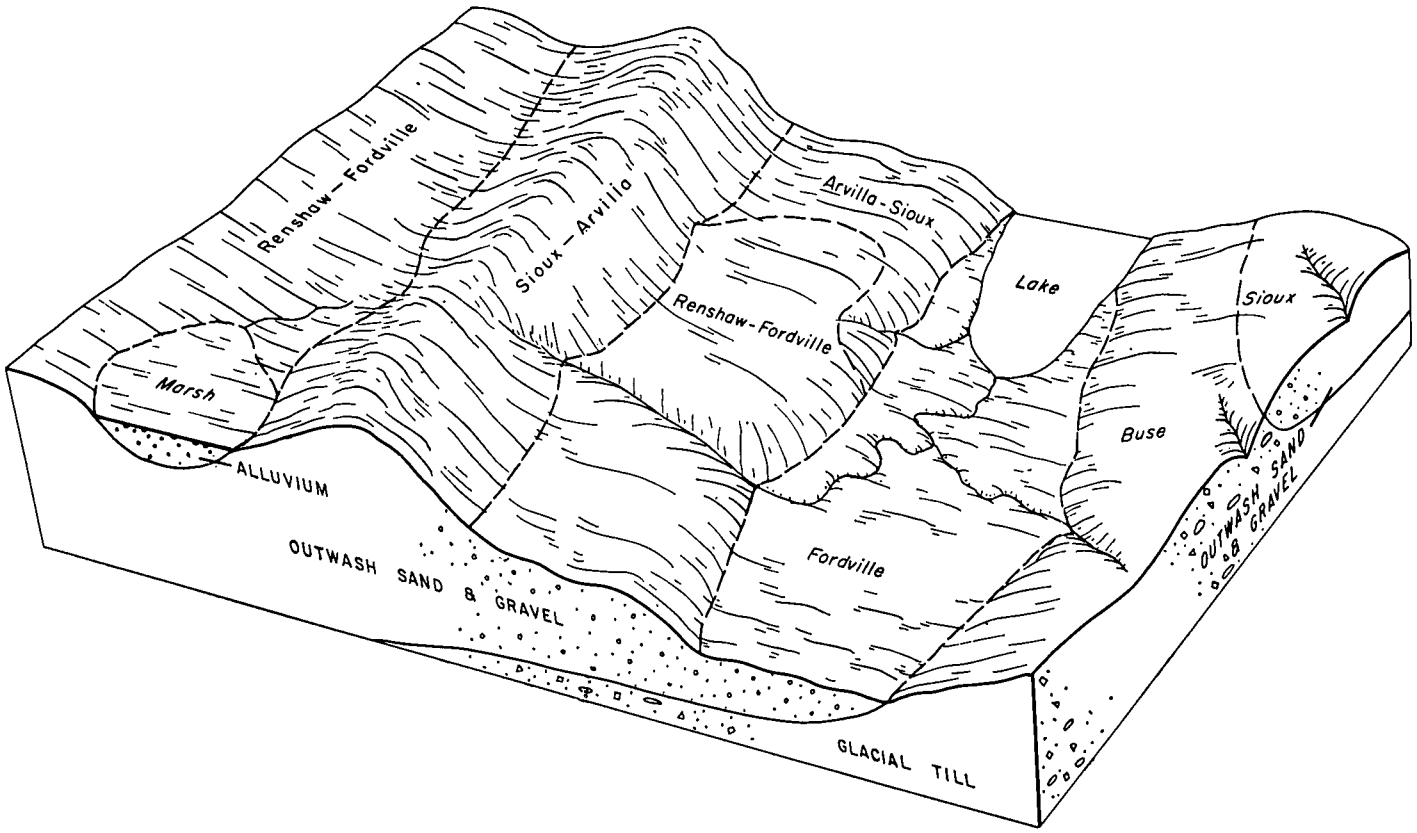

Figure 8.—**Relative position of soils in the Renshaw-Fordville-Sioux association.**

Ludden soils are poorly drained and are calcareous at the surface. They have a very thick surface layer of dark-gray silty clay in the upper part and gray clay in the lower part. The underlying material, below a depth of 32 inches, is gray clay that has reddish-brown mottles.

Figure 9.—**An area of Dovray-Ludden-Lamoure association.**

Lamoure soils are somewhat poorly drained to poorly drained. They are calcareous at the surface but are less clayey than Ludden soils. They have a thick surface layer of very dark gray and dark gray silty clay loam and a subsoil of gray silty clay loam. The underlying material is silty clay loam that has mottled colors.

Among the minor soils are Forman and Peever soils on isolated high areas, Playmoor soils in low areas, and Tonka soils in closed depressions.

The soils of this association are subject to wetness in spring because of flooding and the rise of a fluctuating water table. Permeability is very slow in the Dovray and Ludden soils, and these soils are slow to dry out. Wetness is the main concern of management, but maintaining tilth and improving water intake are also important.

Most of this association is cultivated. Corn, wheat, flax, barley, and alfalfa are the main crops. A few of the more poorly drained areas are used for tame pasture, native range, or wildlife habitat. The sale of small grain is the main source of cash income. Diversified farming is the main enterprise.

Descriptions of the Soils

This section describes the soil series and mapping units in Marshall County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds

true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Sandy lake beaches and Wet alluvial land, for example, do not belong to a soil series, but nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak group in which the mapping unit has been placed. The page for the description of each capability unit, range site, windbreak group, or other interpretative group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

Soil names and delineations shown on the soil maps do not fully agree with those shown on published maps for adjacent counties. Differences are the result of better knowledge of soils, of changes in concepts of soil series, and in the application of the soil classification system, of intensity of mapping, and of the extent of soils within the survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the teminology and methods of soil mapping can be obtained from the Soil Survey Manual (*10*).[2]

Aastad Series

The Aastad series consists of deep, nearly level to strongly sloping, moderately well drained loamy soils that formed in glacial till. These soils are in swales and on toe slopes on uplands.

In a representative profile the surface layer is dark-gray loam about 15 inches thick. The subsoil is dark-gray and grayish-brown clay loam about 13 inches thick. It is hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray and light-gray clay loam. It has reddish-brown mottles.

Fertility and available water capacity are high in Aastad soils. Permeability is moderate in the surface layer and the subsoil and moderately slow in the underlying material.

[2] Italic numbers in parentheses refer to Literature Cited, p. 114.

Many areas are cultivated. Areas where slopes are steeper are used for hay or pasture.

Representative profile of Aastad loam, in grassland area of Forman-Aastad loams, 9 to 15 percent slopes; 1,500 feet north and 60 feet west of the southeast corner of sec. 15, T. 126 N., R. 53 W.:

A11—0 to 10 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky; neutral; clear, smooth boundary.

A12—10 to 15 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium and fine, subangular blocky structure parting to moderate, medium, granular structure; slightly hard, friable, slightly sticky; neutral; clear, smooth boundary.

B2—15 to 25 inches, dark-gray (10YR 4/1) clay loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, firm, sticky, plastic; thin continuous clay films; mildly alkaline; clear, smooth boundary.

B3—25 to 28 inches, dark-gray (10YR 4/1) and grayish-brown (10YR 5/2) clay loam, very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) moist; few, fine, distinct mottles of dark red (2.5YR 3/6) moist; weak, coarse and medium, subangular blocky structure; hard, firm, sticky, plastic; mildly alkaline; abrupt, wavy boundary.

C1—28 to 31 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, medium, prominent mottles of reddish brown (5YR 4/4) moist; massive; hard, firm, sticky; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C2—31 to 44 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; common, fine, faint mottles of reddish brown (5YR 4/4) moist; massive; hard, firm, sticky; common fine threads of segregated lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—44 to 60 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; many, coarse, prominent mottles of reddish brown (5Y 4/4) moist; massive; hard, firm, sticky; few fine threads of segregated lime; strong effervescence; moderately alkaline.

The A horizon is loam or clay loam and ranges from 8 to 16 inches in thickness.

The B horizon ranges from very dark gray to grayish brown in hue of 10YR or 2.5Y. Mottles in the B3 and C horizons are few to many and faint to prominent. The solum ranges from 20 to 30 inches in thickness, and its depth generally coincides with the depth to free lime.

Aastad soils are mapped with Forman soils. They are not so well drained as those soils, and they have a thicker A horizon. They contain more sand and less silt than Waubay soils, which also are in swales and toe slopes on uplands.

Aastad loam, 0 to 2 percent slopes (AaA).—This nearly level soil is in swales and in slight depressions. Areas are long and narrow along small drainageways. The profile is similar to the one described as representative for the series, except that in places the surface layer is silt loam, and in some areas the subsoil is thicker.

Included with this soil in mapping were areas of Forman, Parnell, and Tonka soils. Forman soils are on slight rises. Parnell and Tonka soils are in depressions or in potholes that are less than 2.5 acres in size. Also included are small areas of the land type Marsh that are indicated on the map by a symbol for marsh.

Runoff is slow on this Aastad soil. This soil receives runoff water from adjacent soils, and planting operations are delayed during wet years. In some years crop production is limited by shortage of moisture.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Aastad loam, 0 to 2 percent slopes	3, 199	0. 6
Aberdeen-Exline silty clay loams, 0 to 2 percent slopes	15, 960	2. 9
Arveson fine sandy loam	2, 659	. 5
Arvilla-Sioux loams, 9 to 25 percent slopes	3, 944	. 7
Bearden silt loam	10, 106	1. 9
Bearden-Tonka silt loams, 0 to 3 percent slopes	3, 020	. 6
Benoit and Divide loams	492	. 1
Beotia silt loam, 0 to 2 percent slopes	23, 515	4. 3
Beotia silt loam, 2 to 6 percent slopes	1, 685	. 3
Beotia-Bearden silt loams, 0 to 3 percent slopes	16, 288	3. 0
Buse-Forman loams, 9 to 21 percent slopes	10, 240	1. 9
Buse-Forman loams, 21 to 40 percent slopes	4, 583	. 8
Buse-Forman stony complex, 9 to 40 percent slopes	5, 352	1. 0
Buse-Sioux complex, 15 to 21 percent slopes	1, 820	. 4
Buse-Sioux stony complex, 9 to 40 percent slopes	1, 603	. 3
Colvin silty clay loam	2, 589	. 5
Dovray silty clay	8, 715	1. 6
Edgeley loam, 2 to 6 percent slopes	294	(1)
Edgeley loam, 6 to 9 percent slopes	792	. 1
Edgeley loam, 9 to 15 percent slopes	1, 045	. 2
Embden fine sandy loam, 0 to 2 percent slopes	6, 924	1. 3
Embden fine sandy loam, 2 to 6 percent slopes	5, 787	1. 1
Embden-Buse complex, 2 to 9 percent slopes	1, 295	. 2
Estelline silt loam, 0 to 2 percent slopes	1, 502	. 3
Exline-Aberdeen silty clay loams, 0 to 2 percent slopes	2, 808	. 5
Fordville loam, 0 to 2 percent slopes	511	. 1
Fordville loam, 2 to 6 percent slopes	868	. 2
Forman-Aastad loams, 0 to 2 percent slopes	926	. 2
Forman-Aastad loams, 2 to 6 percent slopes	29, 832	5. 5
Forman-Aastad loams, 6 to 9 percent slopes	35, 331	6. 5
Forman-Aastad loams, 9 to 15 percent slopes	44, 358	8. 1
Forman-Buse loams, 6 to 9 percent slopes, eroded	4, 698	. 9
Forman-Buse loams, 15 to 25 percent slopes	16, 712	3. 1
Forman-Buse stony complex, 6 to 21 percent slopes	4, 703	. 9
Forman-Poinsett complex, 6 to 9 percent slopes	10, 705	2. 0
Forman-Poinsett complex, 9 to 15 percent slopes	8, 451	1. 6
Great Bend silt loam, 2 to 6 percent slopes	4, 543	. 8
Great Bend-Beotia silt loams, 0 to 2 percent slopes	3, 394	. 6
Great Bend-Zell silt loams, 2 to 6 percent slopes	1, 261	. 2
Great Bend-Zell silt loams, 6 to 9 percent slopes	471	. 1
Hamar loamy fine sand	1, 572	. 3
Hamar fine sandy loam	3, 684	. 7
Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes	21, 325	3. 9
Hecla loamy fine sand, 0 to 3 percent slopes	5, 956	1. 1
Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	9, 280	1. 7
Hecla-Venlo complex, 0 to 6 percent slopes, eroded	1, 627	. 3
Kloten-Buse complex, 15 to 40 percent slopes	701	. 1
Kranzburg silt loam, 0 to 2 percent slopes	12, 025	2. 2
Kranzburg silt loam, 2 to 6 percent slopes	9, 400	1. 7
Kranzburg silt loam, 6 to 9 percent slopes, eroded	960	. 2
Kranzburg-Aberdeen silt loams, 0 to 2 percent slopes	2, 050	. 4
Kranzburg-Aberdeen silt loams, 2 to 6 percent slopes	420	. 1
Lamoure silty clay loam	5, 694	1. 1
Loamy alluvial land	3, 933	. 7
Ludden silty clay	5, 049	. 9
Maddock loamy fine sand, 2 to 6 percent slopes	1, 045	. 2
Maddock loamy fine sand, 6 to 15 percent slopes	1, 574	. 3
Marsh	58, 298	10. 8
Oldham silty clay loam	1, 268	. 2
Oldham silty clay loam, saline	1, 129	. 2
Parnell silty clay loam	4, 969	. 9
Peever clay loam, 0 to 2 percent slopes	3, 517	. 7
Peever clay loam, 2 to 6 percent slopes	6, 020	1. 1
Peever clay loam, 6 to 9 percent slopes	440	. 1
Peever-Hamerly complex, 0 to 2 percent slopes	2, 801	. 5
Playmoor silty clay loam	1, 576	. 3
Poinsett-Forman complex, 2 to 6 percent slopes	13, 005	2. 4
Poinsett-Waubay silty clay loams, 0 to 2 percent slopes	1, 117	. 2
Poinsett-Waubay silty clay loams, 2 to 6 percent slopes	2, 752	. 5
Renshaw-Fordville loams, 0 to 3 percent slopes	2, 151	. 4
Renshaw-Fordville loams, 3 to 6 percent slopes	4, 759	. 9
Renshaw-Fordville loams, 6 to 9 percent slopes	3, 451	. 6
Sandy lake beaches	406	. 1
Serden fine sand, 6 to 21 percent slopes, eroded	495	. 1
Serden-Venlo complex, 0 to 6 percent slopes	1, 236	. 2
Sieche loam, 6 to 15 percent slopes	949	. 2
Sieche loam, 21 to 50 percent slopes	4, 138	. 8
Sinai silty clay , 0 to 3 percent slopes	2, 347	. 4
Sinai silty clay, 3 to 6 percent slopes	4, 441	. 8
Sinai silty clay, 6 to 9 percent slopes	797	. 1
Sioux-Arvilla loams, 15 to 40 percent slopes	1, 747	. 3
Stirum-Ulen fine sandy loams	1, 778	. 3
Swenoda fine sandy loam, 0 to 2 percent slopes	4, 927	. 9
Swenoda fine sandy loam, 2 to 6 percent slopes	1, 349	. 3
Swenoda-Larson complex, 0 to 2 percent slopes	419	. 1
Tonka silt loam	2, 830	. 5
Ulen fine sandy loam	8, 250	1. 5
Ulen-Stirum fine sandy loams	4, 023	. 7
Vallers loam	1, 386	. 3
Wet alluvial land	2, 960	. 5
Gravel pits	259	(1)
Open water (less than 40 acres)	1, 518	. 3
Total	542, 784	100. 0
Open water (greater than 40 acres)	24, 256	
Total area	567, 040	

[1] Less than 0.05 percent.

Most areas of this soil are cultivated. This soil is well suited to all crops grown in the county and to pasture and hay plants. The main concern of management is conserving moisture. Capability unit IIc–3; Overflow range site; windbreak group 1.

Aberdeen Series

The Aberdeen series consists of deep, nearly level, moderately well drained or somewhat poorly drained silty soils that formed in lacustrine deposits. These soils are on uplands.

In a representative profile the surface layer is dark-gray silty clay loam about 8 inches thick. Below this is a transitional layer of gray silty clay loam about 3 inches thick. The subsoil is dark-gray and grayish-brown silty clay and silty clay loam about 20 inches thick. It is hard when dry and firm when moist. The lower part of the subsoil is calcareous and contains salt. The underlying material is calcareous, light-gray silty clay loam.

Fertility is medium in Aberdeen soils. Available water capacity is moderate or high, and permeability is slow. In most areas the water table is at a depth of 4 to 10 feet.

Many areas are cultivated. Other areas are in native grass and are used for hay or pasture.

Representative profile of Aberdeen silty clay loam in a cultivated area of Aberdeen-Exline silty clay loams, 0 to 2 percent slopes, 1,840 feet east and 60 feet south of the northwest corner of sec. 6, T. 125 N., R. 58 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; abrupt, smooth boundary.

B&A—8 to 11 inches, gray (10YR 5/1) silty clay loam (B part) very dark gray (10YR 3/1) moist and patches of gray (10YR 6/1) sand and silt grains (A part), dark gray (10YR 4/1) moist; weak, fine, subangular blocky structure parting to moderate, very fine, blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline; gradual, smooth boundary.

B21t—11 to 17 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; moderate, medium, prismatic structure parting to strong, very fine, blocky structure; hard, firm, sticky, plastic; thin, continuous to moderate, patchy, shiny surfaces on peds; moderately alkaline; clear, smooth boundary.

B22t—17 to 22 inches, dark-gray (10YR 4/1) and grayish-brown (2.5Y 5/2) silty clay, very dark brown (10YR 2/2) and very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to strong, very fine, blocky structure; hard, firm, sticky, plastic; thin, continuous to moderate, patchy, shiny surfaces on peds; moderately alkaline; abrupt, wavy boundary.

B3casa—22 to 31 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; very weak, coarse, prismatic structure parting to moderate, very fine, blocky structure; hard, firm, sticky, plastic; thin, patchy, shiny surfaces on peds; common fine nests of salts; strong effervescence; strongly alkaline; clear, smooth boundary.

Cca—31 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) moist; many, fine, distinct mottles of strong brown (7.5YR 5/6) and gray (5Y 5/1) moist; massive; hard, friable, sticky, plastic; few fine nests of salts; few fine masses of segregated lime; strong effervescence; strongly alkaline.

The Ap or A1 horizon is very dark gray or dark gray silty clay loam or silt loam. The B&A or A2 horizon is dark gray or gray and ranges from 2 to 6 inches in thickness. The A2 horizon, where present, has weak, thin, platy structure and weak, fine, granular structure.

The B2t horizon ranges from very dark gray to light brownish gray in hue of 10YR or 2.5Y. It is silty clay, heavy silty clay loam, or clay that has a clay content ranging from 35 to 55 percent. The B2t horizon has moderate or strong prismatic structure that parts to moderate or strong, fine or very fine, blocky structure. Salts are visible in the lower part of the B horizon or upper part of the C horizon. Where the B horizon is less than 15 percent sodium, the sodium plus magnesium exceeds the calcium plus hydrogen.

The C horizon ranges from laminated silt and clay to stratified silt, fine sand, and clay, but in some areas clay loam glacial till is at a depth of less than 40 inches. The solum ranges from 20 to 34 inches in thickness. Depth to carbonates ranges from 16 to about 34 inches.

Aberdeen soils are mapped with Exline and Harmony soils. They have a thicker A horizon than Exline soils and lack the distinct columnar structure of those soils. They contain more sodium and other salts in the B horizon than Harmony soils.

Aberdeen-Exline silty clay loams, 0 to 2 percent slopes (AbA).—Aberdeen soils make up about 45 percent of this complex, Exline soils 30 percent, and other soils 25 percent. Aberdeen soils are in flat areas, and Exline soils are in slightly depressed areas. The Exline soils have a profile similar to the one described as representative for their series, except that in cultivated areas the surface layer is silty clay loam.

Included with these soils in mapping were areas of Bearden and Harmony soils. Harmony soils are the most extensive of these and make up as much as 20 percent of a given area. Harmony soils are on slight rises, and Bearden soils commonly are on the rims of depressions.

Runoff is slow on Aberdeen and Exline soils. These soils are generally wet in spring, and tillage and planting operations are commonly delayed. Both soils have a subsoil that releases moisture slowly to plants and restricts the development of roots and the movement of water and air. Exline soils especially are restrictive because of shallow depth over the claypan and the accumulation of salts in the subsoil at depths of less than 20 inches.

Most areas of these soils are cultivated. Small grain, corn, flax, and alfalfa are the main crops in Aberdeen soils, which are suited to this use. These crops, however, grow poorly on the Exline soils (fig. 10). A few areas of this complex are in native grass and are used as pasture or hayland. This complex is not suited to irrigation.

The main concern of management is improving tilth and increasing the intake of water into the slowly permeable subsoil. Capability unit IIIs–1; Aberdeen soils are in Clayey range site and windbreak group 4; Exline soils are in Thin Claypan range site and windbreak group 10.

Arveson Series

The Arveson series consists of deep, level, very poorly drained, calcareous loamy soils that formed in sandy lacustrine deposits. These soils are in depressions and swales on uplands.

In a representative profile the surface layer is dark-gray and gray fine sandy loam about 14 inches thick. It is soft when dry and very friable when moist. The underlying material, to a depth of 26 inches, is light-gray fine sandy loam. Below this is light-gray loamy fine sand.

Figure 10.—**Corn is stunted on the Exline part of an area of Aberdeen-Exline silty clay loams, 0 to 2 percent slopes.**

The underlying material has red, yellow, and brown mottles.

Fertility is medium or low in Arveson soils. Permeability is moderately rapid, and available water capacity is moderate. A water table is at or near the surface in undrained areas during the early part of the growing season in most years.

Most areas are in native grass and are used for hay and pasture.

Representative profile of Arveson fine sandy loam, 1,940 feet west and 150 feet south of the northeast corner of sec. 25, T. 128 N., R. 59 W.:

A11—0 to 10 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, very friable; many fine snail shells; slight effervescence; moderately alkaline; clear, smooth boundary.

A12—10 to 14 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) moist; common, fine, faint mottles of pale yellow (5Y 8/3) moist; weak, medium and fine, subangular blocky structure; soft, very friable; many fine snail shells; strong effervescence; moderately alkaline; clear, wavy boundary.

C1gca—14 to 26 inches, light-gray (5Y 7/1) fine sandy loam, gray (5Y 5/1) moist; common, medium, distinct mottles of pale yellow (5Y 8/3) moist; slightly hard, very friable; violent effervescence; strongly alkaline; gradual, smooth boundary.

C2g—26 to 45 inches, light-gray (5Y 7/2) loamy fine sand, olive gray (5Y 5/2) moist; common, medium, distinct mottles of reddish brown (5YR 4/4) and yellowish red (5YR 5/6) moist; slightly hard, very friable; strong effervescence; strongly alkaline; gradual, smooth boundary.

C3g—45 to 60 inches, light-gray (5Y 7/2) loamy fine sand, olive gray (5Y 5/2) moist; many, medium, prominent mottles of reddish brown (5YR 4/4), yellowish red (5Y 5/6) and dark brown (7.5YR 4/4) moist; slightly hard, very friable; slight effervescence; moderately alkaline.

The A horizon is black or very dark gray when moist, and hue is 10YR or the color is neutral. This horizon ranges from 8 to 16 inches in thickness. The A and C1gca horizons range from sandy loam to loam or silt loam that has enough sand to have a gritty feel. These horizons, however, are typically fine sandy loam.

The C horizon has colors in hue of 5Y or 2.5Y. It ranges from fine sand to fine sandy loam but typically is loamy fine sand in the lower part. Mottles range from few to many, fine or medium, and faint to prominent.

Arveson soils contain less sand than Hamar, Ulen, and Venlo soils, all of which formed in similar material. They are more poorly drained than Hamar and Ulen soils and are more calcareous than Hamar and Venlo soils.

Arveson fine sandy loam (0 to 1 percent slopes) (Ar).—This soil is mostly in circular areas that are commonly less than 20 acres in size. It has the profile described as representative for the series. In a few areas the underlying material, below a depth of 40 inches, is loam or silt loam.

Included with this soil in mapping were areas of Hecla, Stirum, and Ulen soils. Hecla soils are in higher areas within the depressions and have convex slopes. Stirum soils are in some of the low spots, and Ulen soils are on the outer edges of some of the depressions.

Runoff is very slow on Arveson soil. The water table is at or near the surface during part of the growing season in most years. Availability of plant nutrients is reduced by the high content of lime. Cultivated areas are subject to soil blowing.

Most areas of this soil are in native grass and are used as hayland or as pasture. The main concern of management is wetness. Capability unit Vw–1; Subirrigated range site; windbreak group 10.

Arvilla Series

The Arvilla series consists of rolling to steep, excessively drained, loamy soils that formed in glacial outwash material. These soils are shallow over sand and gravel. They are on uplands.

In a representative profile the surface layer is dark-gray loam about 9 inches thick. The subsoil is dark-brown coarse sandy loam about 8 inches thick. It is slightly hard when dry and friable when moist. The underlying material is dark-brown and brown, calcareous sand and gravel.

Fertility is low in Arvilla soils. Available water capacity is low. Permeability is moderate in the surface layer, moderately rapid in the subsoil, and rapid in the underlying sand and gravel.

Almost all areas are in native grass and are used for hay or pasture.

Representative profile of Arvilla loam under native grass in an area of Arvilla-Sioux loams, 9 to 25 percent slopes; 950 feet east and 335 feet north of the southwest corner of sec. 25, T. 127 N., R. 54 W.:

A11—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, very friable; neutral; clear, wavy boundary.

A12—5 to 9 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; very weak, medium, prismatic structure parting to weak, fine, granular structure; slightly hard, very friable; neutral; clear, wavy boundary.

B2—9 to 17 inches, dark-brown (10YR 4/3) coarse sandy loam, dark brown (10YR 3/3) moist; weak, coarse and medium, prismatic structure parting to weak, coarse and medium, subangular blocky structure; slightly hard, friable; tongues of dark gray (10YR 4/1) on faces of prisms; neutral; clear, wavy boundary.

IIC1—17 to 20 inches, dark-brown (10YR 4/3) loamy coarse sand and gravel, dark brown (10YR 3/3) moist; single grained; loose; slight effervescence; mildly alkaline; gradual boundary.

IIC2—20 to 30 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; slight effervescence; mildly alkaline; gradual boundary.

IIC3—30 to 60 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; slight effervescence; mildly alkaline.

The A horizon ranges from very dark gray to grayish brown in color. Texture is loam or sandy loam. This horizon ranges from 6 to 12 inches in thickness.

The B2 horizon has weak or moderate, medium or coarse, prismatic structure that parts to weak, medium and coarse, subangular blocky structure.

The IIC horizon ranges from loamy sand to coarse sand and gravel. The solum ranges from 14 to 25 inches in thickness.

Arvilla soils are mapped with or are near Renshaw and Sioux soils. They contain more sand than Renshaw soils and are deeper over sand and gravel than Sioux soils.

Arvilla-Sioux loams, 9 to 25 percent slopes (AsE).—Arvilla soils make up 60 percent of this complex, Sioux soils 25 percent, and other soils 15 percent. These soils are rolling to hilly. Areas are mostly less than 40 acres in size and are irregular in shape. Arvilla soils are on the sides of the ridges and draws. The Arvilla soil that has the profile described as representative of the series is in this complex. Sioux soils are on the tops and upper parts of the rounded ridges and knolls and the upper parts of sides of entrenched drainageways. In a few areas stones on the surface in scattered spots commonly indicate the presence of Sioux soils.

Included with these soils in mapping were areas of Fordville and Renshaw soils. They are less steep and are in the parts of the landscape where slopes are slightly longer.

Runoff is slow or medium on Arvilla and Sioux soils, but the soils are subject to erosion and soil blowing if the vegetative cover is inadequate. The soils are droughty and are low in fertility.

Most areas of these soils are in native grass and are used as pasture. The main concern of management is controlling erosion. Capability unit VIe–6; Arvilla soils are in Shallow to Gravel range site; Sioux soils are in Very Shallow range site; both soils are in windbreak group 10.

Bearden Series

The Bearden series consists of deep, nearly level, moderately well drained or somewhat poorly drained, calcareous, silty soils that formed in silty, glacial lacustrine material. These soils are in swales and flat basinlike areas on uplands.

In a representative profile the surface layer is dark-gray silt loam about 9 inches thick. It is soft when dry and friable when moist. Below this is a transitional layer, about 5 inches thick, of gray and very dark gray silt loam. The underlying material is light-gray and gray silt loam. Tongues of the surface layer extend into it to a depth of about 32 inches.

Fertility is medium in Bearden soils. Availability of plant nutrients is affected by the high content of lime. Available water capacity is high, and permeability is slow. These soils have a water table at a depth of 3 to 5 feet. Most areas are cultivated.

Representative profile of Bearden silt loam, in a cultivated area, 1,850 feet south and 140 feet west of the northeast corner of sec. 7, T. 125 N., R. 59 W.:

Ap—0 to 9 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; soft, friable; slight effervescence; moderately alkaline; abrupt, smooth boundary.

ACca—9 to 14 inches, very dark-gray (10YR 3/1) and gray (10YR 5/1) silt loam, black (10YR 2/1) and grayish brown (10YR 5/2) moist; moderate, medium, subangular blocky structure; slightly hard, friable; coarse tongues of dark material from the Ap horizon; strong effervescence; moderately alkaline; gradual, irregular boundary.

C1ca—14 to 21 inches, light-gray (10YR 7/2) and gray (10YR 5/1) silt loam, grayish brown (10YR 5/2) and very dark gray (10YR 3/1) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable; coarse tongues of dark material from the Ap horizon; violent effervescence; moderately alkaline; gradual, irregular boundary.

C2ca—21 to 32 inches, light-gray (2.5Y 7/2) silt loam, light brownish gray (2.5Y 6/2) moist; few, fine, faint mottles of strong brown (7.5YR 5/8), and gray (5Y 5/1) moist; massive; slightly hard, friable; few fine tongues of dark material from the Ap horizon; violent effervescence; strongly alkaline; gradual, wavy boundary.

C3—32 to 60 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; many, medium and coarse, prominent mottles of yellowish red (5Y 4/8), and gray (5Y 5/1) moist; massive; soft, friable; strong effervescence; strongly alkaline.

The A horizon ranges from very dark gray to gray. It is silt loam or silty clay loam. This horizon ranges from 7 to 16 inches in thickness.

The C horizon commonly is silt loam or silty clay loam but is very fine sandy loam in places. Mottles are lacking or are faint in the upper part of the C horizon and distinct or prominent in the lower part. In places the C horizon contains crystals of gypsum.

Bearden soils are mapped with Beotia and Tonka soils. They are not so well drained as Beotia soils, and they are more calcareous. Bearden soils are better drained than Tonka soils, which are not calcareous. They are not so poorly drained as Colvin soils, which formed in similar material. Bearden soils are more silty than Hamerly and Vallers soils, both of which are also high in lime content. They are more silty and contain less sand than the nearby Ulen soils.

Bearden silt loam (0 to 2 percent slopes) (Ba).—This nearly level soil is in swales and in flat basinlike areas. It has the profile described as representative for the series. In cultivated areas there are spots where the surface layer is gray because of the mixing of the surface layer and underlying layer by plowing. Also, in a few areas more very fine sand is in the lower part of the profile than that in the profile described as representative of the series.

Included with this soil in mapping were areas of Beotia and Tonka soils. Beotia soils are in the better drained areas. Tonka soils are in small potholes or depressions.

Fertility is medium in this Bearden soil. Tilth is good. Runoff is slow, and planting operations are delayed in some years because of seasonal wetness. The high content of lime affects the availability of plant nutrients and also causes the soil to blow easily.

Most areas of this soil are cultivated. Small grains, corn, alfalfa, and tame grasses are the main crops. The

main concern of management in cultivated areas is controlling soil blowing. Capability unit IIe–4; Silty range site; windbreak group 1.

Bearden-Tonka silt loams, 0 to 3 percent slopes (BdA).—Bearden soils make up about 50 percent of this complex, Tonka soils 30 percent, and other soils 20 percent. These soils are nearly level. The areas have many very gentle rises and small depressions. Bearden soils are on the rises. Tonka soils are in the depressions.

Included with these soils in mapping were areas of Beotia, Embden, Great Bend, and Harmony soils. Beotia soils are the most extensive of these and commonly make up as much as 20 percent of a given area. Beotia soils are on slightly higher positions within the depressions of Tonka soils. Embden and Great Bend soils are on some of the rises. Harmony soils are intermingled with Bearden soils in some areas.

Permeability is slow in Bearden and Tonka soils, and they dry out slowly. Areas of this complex are subject to wetness because the water table rises and runoff water collects in the depressions. In wet years tillage and planting operations are delayed.

Almost all of the areas of these soils are cultivated. If adequately drained, the soils are suited to most of the crops commonly grown in the county. Controlling wetness is the main concern of management, but controlling soil blowing also is a concern on the Bearden parts of the mapped areas. Capability unit IIw–1; Bearden soils are in Silty range site and windbreak group 1; Tonka soils are in Closed Depression range site and windbreak group 10.

Benoit Series

The Benoit series consists of nearly level, poorly drained or very poorly drained, calcareous, loamy soils that formed in glacial outwash material. These soils are moderately deep over sand and gravel. They are in broad, depressed areas on uplands.

In a representative profile the surface layer is dark-gray loam about 7 inches thick. Below this is a transitional layer of gray loam about 6 inches thick. It is soft when dry and friable when moist. Below this, to a depth of 24 inches, is gray loam and gravelly loam. Below a depth of 24 inches and extending to a depth of 60 inches is light-gray and light-olive sand and gravel. Mottles of yellowish brown and yellow are throughout the material between depths of 13 and 60 inches.

Fertility is medium in Benoit soils. Permeability is moderate in the upper part of the profile and rapid in the underlying sand and gravel. Available water capacity is low. These soils have a water table within a depth of 3 feet during the growing season in most years.

Some areas are cultivated, but most are used for hay or pasture.

Representative profile of Benoit loam in an area of Benoit and Divide loams, 1,500 feet north and 160 feet west of the southeast corner of sec. 12, T. 127 N., R. 53 W.:

A1—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, granular structure; soft, friable, slightly sticky, slightly plastic; slight effervescence; mildly alkaline; clear, smooth boundary.

ACca—7 to 13 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak, very coarse, subangular blocky structure; soft, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual, smooth boundary.

C1gca—13 to 22 inches, gray (N 6/0) loam, dark gray (5Y 4/1) moist; few, fine, distinct mottles of yellowish brown (10YR 5/6) moist; massive; soft, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; clear, wavy boundary.

IIC2gca—22 to 24 inches, gray (N 6/0) gravelly loam, dark gray (5Y 4/1) moist; common, fine, distinct mottles of yellow (10YR 7/8) moist; massive; soft, friable, slightly sticky, slightly plastic; 35 to 60 percent gravel and cobblestones ranging from 2 to 10 millimeters in diameter; violent effervescence; moderately alkaline; gradual, wavy boundary.

IIC3g—24 to 33 inches, light-gray (5Y 7/2) sand and gravel, olive gray (5Y 5/2) moist; common, medium, prominent mottles that are yellow (10YR 7/8) moist; single grained; loose; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC4g—33 to 60 inches, light-olive (5Y 6/2) sand and gravel, olive (5Y 5/3) moist; common, medium, prominent mottles that are yellow (10YR 7/8) moist; single grained; loose; slight effervescence; moderately alkaline.

The A horizon, when moist, is black or very dark gray. It is friable or very friable, and it ranges from 7 to 16 inches in thickness. Effervescence is slight or strong. The AC horizon and the upper part of the C horizon are loam or clay loam and have a distinct accumulation of calcium carbonate. In places tongues of material from the A horizon extend into the AC and C horizons. Mottles are distinct or prominent in the ACca horizon, in the C1gca horizon, or in both. Strata of sand and gravel are common in the IIC horizon, but in places this material is mixed in with the other material. Depth to sand and gravel ranges from 14 to 24 inches.

Benoit soils are similar to Arveson, Divide, and Vallers soils. They contain less sand than Arveson soils, which lack gravel in the C horizon. Benoit soils are more poorly drained than Divide soils, and they have mottled colors within a depth of 20 inches that are lacking in Divide soils. They have a C horizon of sand and gravel that is lacking in Vallers soils.

Benoit and Divide loams (0 to 2 percent slopes) (Be).—Benoit soils are dominant in the areas mapped in the extreme eastern part of the county, and Divide soils are dominant in areas mapped in the central part. Some areas include both soils, but proportions of each differ from one area to another. These soils are on broad flats on uplands.

Included with these soils in mapping were areas of Fordville, Lamoure, and Renshaw soils. Fordville and Renshaw soils are on slight rises. Lamoure soils are along poorly defined drainageways, mainly with Divide soils in the central part of the county.

Benoit and Divide soils are productive, but availability of plant nutrients is reduced by the high content of lime. Wetness caused by a high water table and flooding caused by runoff from adjacent soils make farming extremely hazardous on the Benoit soils. The Divide soils have a water table in the root zone early in the growing season, but they are somewhat droughty late in summer after the water table has receded.

Some areas of these soils are cultivated. Spring-seeded small grain and flax are suitable crops on the Divide soils. The Benoit soils are better suited to native pasture or hay than to other uses. Benoit soils are in capability unit Vw–1, Wet Land range site, and windbreak group 10; Divide soils are in capability unit IIIs–4, Silty range site, and windbreak group 2.

Beotia Series

The Beotia series are deep, nearly level to gently sloping, well-drained, silty soils that formed in silty glacial-lacustrine material. These soils are on uplands.

In a representative profile the surface layer is dark-gray silt loam about 7 inches thick. The subsoil is silt loam about 25 inches thick. It is dark gray in the upper part, dark grayish brown in the middle part, and light brownish gray in the lower part. Material in the subsoil is slightly hard when dry and friable when moist. The lower part of the subsoil is calcareous. Below the subsoil is calcareous, light-gray silt loam.

Fertility is high in Beotia soils. Available water capacity is high, and permeability is moderate.

Most areas are cultivated. Beotia soils are well suited to all crops commonly grown in the county.

Representative profile of Beotia silt loam, in a cultivated area, 0 to 2 percent slopes, 2,140 feet west and 150 feet north of the southeast corner of sec. 9, T. 126 N., R. 59 W.:

Ap—0 to 5 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; abrupt, smooth boundary.

A12—5 to 7 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, very coarse, subangular blocky structure parting to moderate, medium, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B21—7 to 15 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; weak, coarse and medium, prismatic structure structure parting to moderate, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B22—15 to 25 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (2.5Y 3/2) moist; weak, coarse and medium, prismatic structure parting to moderate, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; abrupt, wavy boundary.

B3ca—25 to 32 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) moist; weak, medium, subanguar blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few fine segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C1cacs—32 to 42 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common medium salt clusters; strong effervescence; moderately alkaline; clear, smooth boundary.

C2—42 to 60 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; common fine and medium mottles of brownish yellow (10YR 6/6) and light gray (5Y 7/1); massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark gray. It ranges from 6 to 12 inches in thickness.

The B horizon ranges from dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is silt loam or silty clay loam and has a clay content ranging from 18 to 30 percent. The prismatic structure is weak or moderate in grade and medium or coarse in size.

The C horizon is silt loam and silty clay loam that commonly is laminated with silt, fine sand, and clay. Slight to moderate amounts of salt are visible in the C horizon. The solum ranges from 16 to 32 inches in thickness.

Beotia soils are mapped with Bearden and Great Bend soils, are near Colvin soils, and are similar to Kranzburg and Waubay soils. They are better drained than the calcareous Bearden and Colvin soils. When moist, Beotia soils have colors of very dark gray or darker to greater depths than Great Bend and Kranzburg soils. They are better drained than Waubay soils.

Beotia silt loam, 0 to 2 percent slopes (BfA).—This soil is nearly level. Areas are irregular in shape and are mostly about 60 acres in size. Slopes are flat to slightly convex. This soil has the profile described as representative for the series. In some areas it contains slightly more fine sand than that in the representative profile.

Included with this soil in mapping were areas of Bearden and Great Bend soils. Bearden soils are in some of the low areas, and Great Bend soils are on some of the slight rises.

Fertility is high in this Beotia soil. This soil is easy to work. Runoff is slow, and the areas commonly receive additional moisture because of runoff from adjacent soils. The hazard of erosion is little or none. The hazard of soil blowing is slight.

Most areas of this soil are cultivated. Wheat, corn, flax, barley, and alfalfa are the main crops. Conserving moisture is the main concern of management. Capability unit IIc–3; Silty range site; windbreak group 3.

Beotia silt loam, 2 to 6 percent slopes (BfB).—This soil is gently sloping. Areas are irregular in shape and range from 10 to 50 acres in size. Slopes are mostly long, smooth, and slightly convex. The profile of this soil is similar to the one described as representative for the series, except that in some areas the soil is more loamy.

Included with this soil in mapping were areas of Great Bend soils on the higher parts of the landscape.

Fertility is high in this Beotia soil. Tilth is good. Runoff is medium, and there is some hazard of erosion. The hazard of soil blowing is slight.

Most areas of this soil are cultivated. This soil is well suited to all crops commonly grown in the county. Controlling erosion is the main concern of management. Capability unit IIe–3; Silty range site; windbreak group 3.

Beotia-Bearden silt loams, 0 to 3 percent slopes (BhA).—Beotia soils make up about 60 percent of this complex and Bearden soils 40 percent. Areas are as much as 200 acres or more in size. The well-drained Beotia soils are on slight rises, and the Bearden soils are in the lower and more nearly level parts of the areas. Profiles of these soils are similar to the ones described as representative for their respective series except the surface layer in some areas is silty clay loam or very fine sandy loam, and the subsoil in some areas is more loamy. Also, in some areas the surface layer of the Bearden soils is gray because of mixing of the upper horizons by plowing.

Included with these soils in mapping were areas of Great Bend and Tonka soils. Great Bend soils are on the upper parts of some of the rises and gentle undulations. Tonka soils are in small potholes.

Fertility is medium or high in these Beotia and Bearden soils. Tilth is good. Runoff is slow, and Bearden silt loam is subject to wetness in spring. The high content of lime in the Bearden soil affects the availability of plant nutrients and causes the soil to blow easily.

Most areas of these soils are cultivated. They are suited to most of the crops grown in the county. Controlling soil blowing is the main concern of management. Capability unit IIe–4; Silty range site; Beotia soils are in windbreak group 3; Bearden soils are in windbreak group 1.

Buse Series

The Buse series consists of deep, undulating to steep, well-drained, loamy soils that formed in calcareous glacial till. These soils are on uplands.

In a representative profile (fig. 11) the surface layer is dark-gray loam about 4 inches thick. Below this is a transitional layer of calcareous, dark grayish-brown and grayish-brown clay loam about 4 inches thick. This layer is slightly hard when dry and friable when moist. Below this, to a depth of 60 inches, is calcareous, light brownish-gray and light-gray light clay loam.

Fertility is low or medium in the Buse soils. Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow below a depth of about 21 inches.

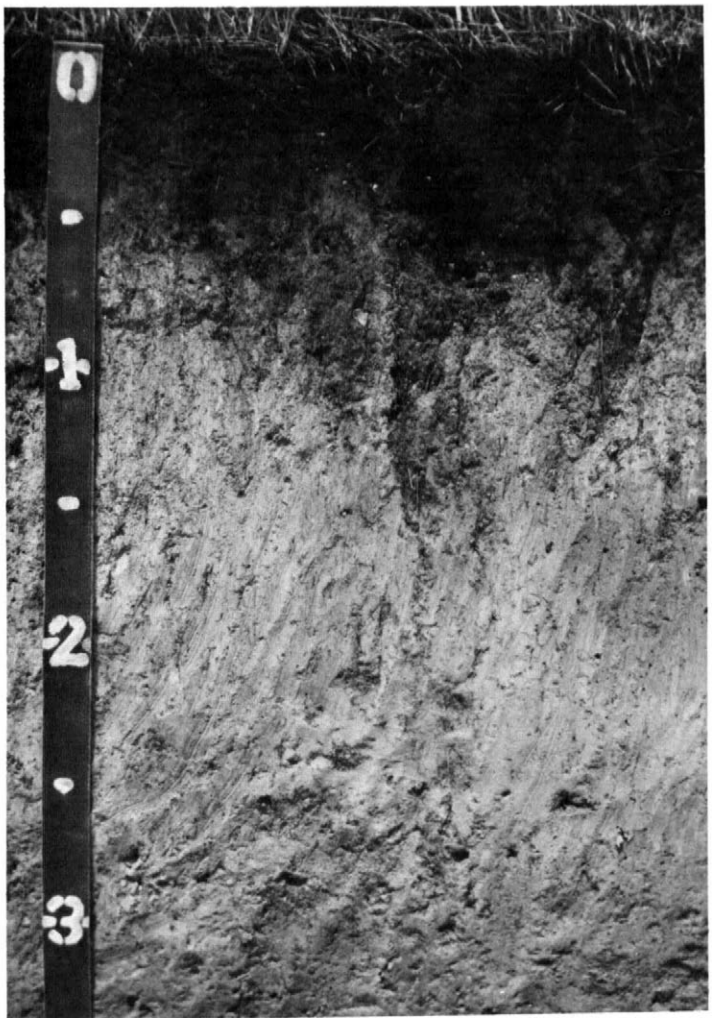

Figure 11.—**Profile of Buse loam.**

Most areas are in native grass and are used for pasture.

Representative profile of Buse loam under native grass in an area of Buse-Forman stony complex, 9 to 40 percent slopes, 1,700 feet north and 75 feet east of the southwest corner of sec. 23, T. 126 N., R. 53 W.:

A1—0 to 4 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline; clear, smooth boundary.

AC—4 to 8 inches, dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) light clay loam, very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure parting to moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky, slightly plastic; slight effervescence; mildly alkaline; gradual, smooth boundary.

C1ca—8 to 21 inches, light brownish-gray (2.5Y 6/2) light clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky, plastic; common fine segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C2ca—21 to 60 inches, light-gray (2.5Y 7/2) light clay loam, light olive brown (2.5Y 5/4) moist; common, fine prominent mottles of red (2.5YR 4/6) moist and many, medium and coarse, distinct mottles of strong brown (7.5YR 5/6) moist; massive; hard, firm, sticky, plastic; common medium segregations of lime; strong effervescence; moderately alkaline.

The A horizon is dark-gray or gray loam or clay loam. It is commonly calcareous, especially in cultivated areas. The AC horizon has weak, fine through coarse, subangular blocky structure or weak or moderate, fine or medium, granular structure. The combined thickness of the A and AC horizons ranges from 6 to 14 inches.

The C horizon is glacial till that is friable or firm loam or clay loam. In places it contains small amounts of gravel. Pebbles and stones on the surface and in the profile range from few to many.

Buse soils are mapped with Forman and Sioux soils and are similar to Zell soils. They have a thinner A horizon than Forman soils and lack the B horizon of these soils. They have a C horizon that contains more clay and lacks the sand and gravel of the Sioux soils. They contain more clay and less silt than Zell soils.

Buse-Forman loams, 9 to 21 percent slopes (BkE).—Buse soils make up about 45 percent of this complex, Forman soils about 30 percent, and other soils 25 percent. These soils are rolling to hilly. Buse soils are on the higher parts of the landscape. Forman soils are less steep and are on the mid and lower parts of side slopes. The Buse and Forman soils have profiles similar to the ones described as representative for their respective series, but in a few areas the Forman soils contain slightly less clay in the subsoil.

Included with these soils in mapping were areas of Aastad, Parnell, Renshaw, and Sioux soils. Aastad, the most extensive of these soils, are on foot slopes and in swales. Parnell soils are in small potholes. Renshaw and Sioux soils are on rounded hilltops mantled with small pockets of gravel.

Runoff is medium or rapid on these Buse and Forman soils, and they are susceptible to erosion. Buse soils are low or medium in fertility.

Almost all of the areas are in native grass and are used for hay and pasture. Forman soils are suitable for cultivation where the areas are large enough to be used

separately. Controlling erosion is the main concern of management. Capability unit VIe–3; Buse soils are in Thin Upland range site and windbreak group 10; Forman soils are in Silty range site and windbreak group 3.

Buse-Forman loams, 21 to 40 percent slopes (BkF).—Buse soils make up about 55 percent of this complex, Forman soils 20 percent, and other soils 25 percent. These soils are steep. Many of the areas consist of side slopes of long drainageways that dissect uplands in the eastern part of the county. The Buse soils are on ridges and the upper sides of drainageways. They have a profile similar to the one described as representative of the series, but in places the surface layer is thinner. The Forman soils are in the mid and lower positions of the landscape. They have a profile similar to the one described as representative for their series, but on some of the lower positions of the landscape their surface layer is thicker.

Included with these soils in mapping were areas of Aastad, Lamoure, Renshaw, and Sioux soils. Aastad soils are the most extensive of these. They are in swales. Lamoure soils are on bottom lands along drainageways in the wider draws. Renshaw and Sioux soils are on rounded ridges mantled with pockets of gravel. Also included are outcrops of shale.

Runoff is rapid on these Buse and Forman soils. The hazard of erosion is high. Buse soils are low or medium in fertility.

These soils are in native grass and are used for pasture. Many of the soils are too steep for the use of farm machinery. Controlling erosion is the main concern of management. Capability unit VIIe–3; Buse soils are in Thin Upland range site; Forman soils are in Silty range site; both soils are in windbreak group 10.

Buse-Forman stony complex, 9 to 40 percent slopes (BmF).—Buse soils make up 55 percent of this complex, Forman soils 25 percent, and other soils 20 percent. These soils are rolling to steep. Areas are irregular in shape, and some are long and narrow along deeply entrenched drainageways. Buse soils are on the ridges and higher parts of the landscape. Forman soils are on the lower parts of side slopes. The Forman soils have a profile similar to the one described as representative for their series, but they commonly have a thicker surface layer. Stony areas as much as 5 acres in size are scattered throughout the complex, especially in the Buse part. The stones are about 2 to 5 feet apart.

Included with these soils in mapping were areas of Aastad, Parnell, Renshaw, and Sioux soils. Of these, Aastad soils are the most extensive. They are on foot slopes and in swales. Parnell soils are in small potholes. Renshaw and Sioux soils are on rounded ridges or knolls mantled with pockets of gravel. Also included are Marsh areas in some of the small potholes.

Runoff is rapid on these Buse and Forman soils. There is a hazard of erosion in areas that have an inadequate vegetative cover. Use of machinery is not practical in the stony and more steeply sloping parts of the complex.

These soils are in native grass and are used for pasture. Stoniness and controlling erosion are concerns of management. Capability unit VIIs–6; Buse soils are in Thin Upland range site; Forman soils are in Silty range site; both soils are in windbreak group 10.

Buse-Sioux complex, 15 to 21 percent slopes (BsE).—Buse soils make up about 40 percent of this complex, Sioux soils 35 percent, and other soils 25 percent. These soils are hilly. Areas are irregular in shape and are mainly less than 40 acres in size. Sioux soils are mainly on the rounded ridges and knolls that are mantled with sand and gravel.

Included with these soils in mapping were areas of Fordville, Forman, Parnell, and Renshaw soils. Fordville and Renshaw soils are on some of the less steep side slopes below Sioux soils. Forman soils are on some of the smoother side slopes below Buse soils. Also included are Parnell soils and small spots of Marsh in small potholes.

Fertility is low or medium in these Buse and Sioux soils. The Sioux soils are droughty. Runoff is rapid on the Buse soils.

These soils are in native grass and are used for pasture. The soils are not suited to cultivation. Controlling erosion is the main concern of management. Capability unit VIe–3; Buse soils are in Thin Upland range site; Sioux soils are in Very Shallow range site; both soils are in windbreak group 10.

Buse-Sioux stony complex, 9 to 40 percent slopes (BtE).—Buse soils make up 40 percent of this complex, Sioux soils 40 percent, and other soils 20 percent. These soils are on ridges and knolls. The areas are irregular in shape. Sioux soils commonly are on the more rounded ridges that contain pockets of gravel. Stones and cobblestones commonly are concentrated in scattered spots as much as 5 acres in size.

Included with these soils in mapping were areas of Aastad, Forman, Parnell, and Renshaw soils. Aastad soils are on foot slopes and in swales. Forman soils are below Buse soils and just above the Aastad soils. Also included are Parnell soils and spots of Marsh in depressions and Renshaw soils near Sioux soils.

Runoff is rapid in the Buse soils. The Sioux soils are droughty. Fertility is low or medium in soils of this complex. They are too stony for cultivation.

These soils are in native grass and are used for pasture. Capability unit VIIs–6; Buse soils are in Thin Upland range site; Sioux soils are in Very Shallow range site; both soils are in windbreak group 10.

Colvin Series

The Colvin series consists of deep, level, poorly drained, calcareous, silty soils that formed in alluvium and silty lacustrine material. These soils are in shallow depressions and low swales on uplands.

In a representative profile the surface layer is dark-gray silty clay loam about 10 inches thick. Below this is light-gray silty clay loam that has mottles of strong brown to light yellowish brown, is high in content of lime, and has nests of gypsum crystals.

Fertility is medium in Colvin soils. Available water capacity is moderate or high. Permeability is moderately slow. The water table fluctuates between depths of 1 and 5 feet.

Many areas are cultivated. Other areas are used for hay and pasture.

Representative profile of Colvin silty clay loam, in a cultivated area, 2,540 feet north and 100 feet east of the southwest corner of sec. 4, T. 125 N., R. 59 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; cloddy parting to moderate, fine and very fine, granular structure; slightly hard, friable, slightly sticky, slightly plastic; slight effervescence; mildly alkaline; abrupt, smooth boundary.

A12—7 to 10 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, very coarse, subangular blocky structure parting to moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; gradual, irregular boundary.

C1cacs—10 to 19 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 5/1) moist; common, medium and coarse, distinct mottles of light yellowish brown (2.5Y 6/4) and strong brown (7.5YR 5/6) moist; laminated; hard, firm, slightly sticky, slightly plastic; tongues of material from A horizon; common fine and medium nests of gypsum crystals; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2cacs—19 to 38 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 5/1) moist; many, medium and coarse, prominent mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) moist; laminated; hard, firm, slightly sticky, slightly plastic; many medium and coarse nests of gypsum crystals; violent effervescence; moderately alkaline; clear, wavy boundary.

C3g—38 to 50 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 5/1) moist; many, coarse, prominent mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) moist; laminated; hard, firm, slightly sticky, slightly plastic; strong effervescence; strongly alkaline; clear, wavy boundary.

C4g—50 to 60 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 5/1) moist; many, coarse, prominent mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) moist; laminated; hard, firm, slightly sticky, slightly plastic; common medium and coarse nests of gypsum crystals; strong effervescence; strongly alkaline.

The A horizon has colors in hue of 10YR or is neutral. It ranges from 6 to 16 inches in thickness.

The Cca horizon has colors in hue of 5Y or 2.5Y. Nests of gypsum crystals in the C horizon range from none to many. The profile is silty clay loam or silt loam to a depth of 40 inches and has a clay content ranging from 24 to 35 percent.

Colvin soils are similar to Arveson, Bearden, and Vallers soils. They are more silty and contain less sand than Arveson and Vallers soils. They are more poorly drained than Bearden soils and have mottled colors at depths of less than 20 inches.

Colvin silty clay loam (0 to 1 percent slopes) (Co).—This soil is in shallow depressions and low swales. Areas are irregular in shape and are mostly 20 acres or more in size.

Included with this soil in mapping were areas of Bearden soils on slight rises on the edges of the areas. Also included in some areas was a soil that is similar to Colvin soils except the underlying material is silty clay.

This soil has a high water table, and it is wet early in the growing season. Tillage and seeding operations commonly are delayed in spring. In some years cultivation in summer is delayed by wetness. The choice of plants is limited by the high water table and the high content of lime.

Many areas of this soil are cultivated. If adequately drained, this soil is suited to most of the crops commonly grown in the county. Areas that are not adequately drained are used for hay and pasture. Wetness is the main concern of management. Capability unit IIw–3 drained, IVw–1, undrained; Subirrigated range site; windbreak group 2.

Divide Series

The Divide series consists of nearly level, moderately well drained or somewhat poorly drained, calcareous, loamy soils that formed in glacial outwash material. These soils are moderately deep over sand and gravel. They are on uplands.

In a representative profile the surface layer is dark-gray loam about 10 inches thick. The underlying material is light brownish-gray loam to a depth of 30 inches. It is slightly hard when dry and friable when moist. Below this is about 6 inches of coarse sandy loam. Sand and gravel are below a depth of 36 inches.

Fertility is medium in Divide soils. Available water capacity is low or moderate. Permeability is moderately rapid in the upper part of the soil and rapid in the underlying sand and gravel. A water table is at depths between 3 and 5 feet during part of the growing season in most years.

Some areas are cultivated. Other areas are in native grass and are used for hay and pasture.

Divide soils in Marshall County are mapped only with Benoit soils.

Representative profile of Divide loam in a cultivated area of Benoit and Divide loams, 1,815 feet south and 1,305 feet west of the northeast corner of sec. 21, T. 127 N., R. 57 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; cloddy parting to weak, fine, granular structure; slightly hard, very friable; common fine pores; slight effervescence; mildly alkaline; abrupt, smooth boundary.

A12—7 to 10 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; cloddy parting to weak, fine, granular structure; slightly hard, very friable; common fine pores; slight effervescence; moderately alkaline; clear, wavy boundary.

C1ca—10 to 17 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable; common fine pores; tongues of material from A horizon; violent effervescence; moderately alkaline; clear, wavy boundary.

C2ca—17 to 30 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable; common fine segregations of lime; violent effervescence; strongly alkaline; clear, wavy boundary.

IIC3—30 to 36 inches, light-gray (2.5Y 7/2) coarse sandy loam, grayish brown (2.5Y 5/2) moist; common fine, distinct mottles of yellowish brown (10YR 5/6) moist; very weak, medium, subangular blocky structure; slightly hard, friable; strong effervescence; strongly alkaline; clear, wavy boundary.

IIC4—36 to 60 inches, light brownish-gray (2.5Y 6/2) sand and gravel, grayish brown (2.5Y 5/2) moist; single grained; loose; moderately alkaline.

The A horizon, when moist, is black or very dark gray in hue of 10YR or 2.5Y. It is commonly loam but in places is silt loam or sandy loam.

Proportions of sand, gravel, and shale pebbles in the IIC horizon differ from one area to another, depending on the

source of the outwash material. Mottles in the C horizon are at a depth of 20 to 40 inches. Depth to sand and gravel ranges from 20 to 36 inches.

Divide soils are near Benoit, Fordville, and Vallers soils. They are better drained than Benoit and Vallers soils, and mottled colors are at a greater depth in Divide soils. Divide soils lack a B horizon and are more poorly drained than Fordville soils.

Dovray Series

The Dovray series consists of deep, level, poorly drained, clayey soils that formed in alluvium or in lacustrine clay. These soils are on bottom lands and in depressions on uplands.

In a representative profile the surface layer is dark-gray silty clay about 22 inches thick. The subsoil is calcareous, dark-gray clay about 10 inches thick. The underlying material is calcareous, gray silty clay and contains a few nests of gypsum crystals.

Fertility is medium or high in Dovray soils. Available water capacity is moderate. Permeability is very slow. The water table rises during the early part of the growing season but recedes to a depth of more than 4 feet late in summer.

Many areas are cultivated. Others are used for hay and pasture.

Representative profile of Dovray silty clay in a cultivated area, 1,300 feet west and 280 feet north of the center of sec. 21, T. 125 N., R. 59 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; cloddy parting to moderate, fine, granular structure; hard, friable, sticky, plastic; mildly alkaline; abrupt, smooth boundary.

A12—7 to 18 inches, dark-gray (N 4/0) heavy silty clay, black (N 2/0) moist; moderate, very coarse and coarse, prismatic structure parting to moderate, fine and very fine, blocky structure; hard, firm, sticky, plastic; mildly alkaline; gradual, smooth boundary.

A13—18 to 22 inches, dark-gray (N 4/0) silty clay, black (N 2/0) moist; few, fine, faint mottles of dark brown moist; weak, coarse and very coarse, prismatic structure parting to moderate, fine and very fine, blocky structure; hard, firm, sticky, plastic; mildly alkaline; abrupt, wavy boundary.

B2g—22 to 32 inches, dark-gray (5Y 4/1) clay, black (5Y 2/1) moist; few, fine, faint mottles of dark yellowish brown (10YR 4/4) moist; weak, very coarse and coarse, prismatic structure parting to weak, fine, subangular blocky structure; hard, firm, sticky, plastic; few fine segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

Ccacs—32 to 60 inches, gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; few, fine, faint mottles of dark yellowish brown (10YR 4/4) moist; massive; hard, firm, sticky, plastic; few fine nests of gypsum crystals; strong effervescence; moderately alkaline.

The A horizon is neutral or mildly alkaline in reaction. It ranges from 6 to 26 inches in thickness.

The B horizon, when moist, is black or very dark gray. Hue is 2.5Y, 5Y, or N (neutral). The combined thickness of the A and B horizons ranges from 28 to 48 inches.

The C horizon commonly is silty clay, but in places it is laminated silt and clay.

Throughout the profile texture is silty clay or clay, and the clay content ranges from 45 to 60 percent. Mottles throughout the profile are faint or distinct. Depth to lime ranges from 20 to 50 inches.

Dovray soils are similar to Lamoure and Ludden soils. They are not so calcareous as those soils, and they are more clayey than Lamoure soils.

Dovray silty clay (0 to 1 percent slopes) (Do).—This level soil is on bottom lands and in depressions. Areas average about 60 acres in size. This soil has the profile described as representative for the series. In a few areas, however, the depth to lime is as shallow as 10 inches. Included in mapping were areas of Ludden soils.

Runoff and permeability are very slow in this Dovray soil. It is generally wet in spring because of the rise of the water table. If the soil is cultivated when it is wet, it puddles and loses its tilth.

Many areas of this soil are cultivated. If adequately drained, this soil is suited to most of the crops commonly grown in the county. Other areas are used for hay and pasture. Wetness is the main concern of management. Capability unit IIw–1; Clayey range site; windbreak group 2.

Edgeley Series

The Edgeley series consists of gently sloping to strongly sloping, well-drained, loamy soils that formed in a thin mantle of loamy glacial till. These soils are moderately deep over shaly glacial till or bedded shale. They are on uplands.

In a representative profile the surface layer is dark-gray loam about 7 inches thick. The subsoil is clay loam about 20 inches thick. It is dark gray in the upper part, grayish brown in the middle part, and light brownish gray in the lower part. It is slightly hard when dry and friable when moist. The underlying material, to a depth of 41 inches, is calcareous, light-gray shaly clay loam. Below this depth is bedded, gray shale that has many mottles of strong brown.

Fertility is medium in Edgely soils. Available water capacity and permeability are moderate.

Many areas are in native grass and are used for hay or pasture. Areas where the soil is gently sloping are cultivated.

Representative profile of Edgeley loam, 6 to 9 percent slopes, 2,140 feet west and 1,200 feet north of the southeast corner of sec. 22, T. 125 N., R. 58 W.:

A1—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B21—7 to 15 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; thin, patchy, shiny surfaces on peds; mildly alkaline; gradual, smooth boundary.

B22—15 to 23 inches, grayish-brown (10YR 5/2) clay loam, very dark gray (10YR 3/1) crushing to dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; thin, very patchy, shiny surfaces on peds; mildly alkaline; gradual, smooth boundary.

B3—23 to 27 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky, plastic; 10 percent shale chips; mildly alkaline; gradual, wavy boundary.

C1—27 to 41 inches, light-gray (2.5Y 7/2) shaly clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct mottles of strong brown (7.5YR 5/6) moist; massive; slightly hard, friable, sticky, plastic; 40 percent shale chips; few fine segregations of lime; strong effervescence; moderately alkaline; abrupt, smooth boundary.

IIC2—41 to 60 inches, gray (5Y 6/1) shale, very dark gray (5Y 3/1) moist; many, fine, medium and coarse, prominent mottles of strong brown (7.5YR 5/6) moist; bedded shale breaks to fine to coarse platy structure; few fine segregations of lime; slight effervescence in spots; mildly alkaline.

The A horizon, when moist, is black or very dark gray, and hue is 10 YR or 2.5Y. It is commonly loam. The combined thickness of the A and B horizons ranges from 16 to 36 inches.

The C1 horizon ranges from loam to clay in texture. The content of shale chips in the C1 horizon ranges from 10 to 60 percent. In places the C horizon is noncalcareous. Depth to bedded shale ranges from 30 to 60 inches.

Edgeley soils are near Buse, Forman, Kloten, and Kranzburg soils. They differ from Buse, Forman, and Kranzburg soils in having bedded shale at depths between 30 and 60 inches. They are deeper over shale than Kloten soils.

Edgeley loam, 2 to 6 percent slopes (EdB).—This soil is gently sloping. The areas are irregular in shape and commonly less than 20 acres in size. This soil has a profile similar to the one described as representative for the series, except that the surface layer is slightly thicker and in some areas it is silty clay loam.

Included with this soil in mapping were areas of Aastad and Forman soils. Aastad soils are on foot slopes and in swales. Forman soils are in spots that are deeper over shale or shaly till.

Permeability is moderate above the shale in this Edgeley soil. It is somewhat droughty. Tilth is good. Runoff is medium, and there is some hazard of erosion.

Many areas of this soil are cultivated. Controlling erosion is the main concern of management. Capability unit IIe–1; Silty range site; windbreak group 6.

Edgeley loam, 6 to 9 percent slopes (EdC).—This soil is sloping. The areas are irregular in shape and are mostly less than 40 acres in size. It has the profile described as representative for the series. In some areas the surface layer and subsoil are silty clay loam.

Included with this soil in mapping were areas of Aastad, Buse, and Forman soils. Aastad soils are on foot slopes and in swales. Buse soils are on the tops of ridges and knolls. Forman soils are in places that have underlying material of clay loam till instead of shale or shaly till.

Runoff is medium in this Edgeley soil. It is easily worked, but it is somewhat droughty. The hazard of erosion is moderate.

Many areas of this soil are in native grass and are used for pasture and hay. Other areas are cultivated. Controlling erosion is the main concern of management. Capability unit IIIe–1; Silty range site; windbreak group 6.

Edgeley loam, 9 to 15 percent slopes (EdD).—This soil is strongly sloping. The areas are irregular in shape and are mostly less than 50 acres in size. This soil has a profile similar to the one described as representative for the series, except that in places the surface layer and subsoil are thinner. Small areas that are stony on the surface are in some areas, and in a few areas the surface layer and subsoil are silty clay loam.

Included with this soil in mapping were areas of Aastad, Buse, and Forman soils. Aastad soils are on foot slopes and in swales. Buse soils are on the higher parts of the landscape. Forman soils are in spots where the mantle of glacial till is thicker.

Runoff is medium in this Edgeley soil. Available water capacity is moderate. This soil is somewhat droughty. The hazard of erosion is severe.

Most areas of this soil are in native grass and are used for pasture and hay. This soil can be cultivated, but the hazard of erosion is a limitation. Capability unit IVe–1; Silty range site; windbreak group 6.

Embden Series

The Embden series consists of deep, nearly level to gently undulating, well drained or moderately well drained, loamy soils that formed in fine sandy loam deposited by wind or glacial melt water. These soils are on uplands.

In a representative profile the surface layer is dark-gray and dark grayish-brown fine sandy loam about 15 inches thick. The subsoil is grayish-brown fine sandy loam about 19 inches thick. It is slightly hard when dry and very friable when moist. The underlying material is pale-brown loamy fine sand and fine sandy loam.

Fertility is medium in Embden soils. Available water capacity is moderate or high. Permeability is moderately rapid. These soils are highly susceptible to blowing.

Many areas are cultivated. Other areas are in native grass and are used for hay and pasture.

Representative profile of Embden fine sandy loam, 0 to 2 percent slopes, 2,580 feet north and 280 feet west of the southeast corner of sec. 32, T. 128 N., R. 58 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—6 to 15 inches, dark grayish-brown (10YR 4/2) fine sandy loam, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; weak, very coarse and coarse, prismatic structure parting to weak, medium, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

B2—15 to 34 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, very friable; mildly alkaline; clear, smooth boundary.

C1—34 to 40 inches, pale-brown (10YR 6/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; mildly alkaline; clear, smooth boundary.

C2—40 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; common, fine, faint mottles of yellowish brown (10YR 5/6) moist; single grained; soft, very friable; mildly alkaline.

The A horizon ranges from very dark gray to gray. It is fine sandy loam or sandy loam. This horizon ranges from 10 to 20 inches in thickness.

In places the lower part of the B horizon is loamy fine sand. The combined thickness of the A and B horizons ranges from 20 to 44 inches.

In places the C horizon is calcareous, and in places it is loam at a depth of more than 40 inches.

Embden soils are similar to Hecla, Maddock, and Swenoda soils. They are less sandy than Hecla and Maddock soils.

They differ from Swenoda soils in not having silty material in the C horizon at a depth of less than 40 inches.

Embden fine sandy loam, 0 to 2 percent slopes (EmA).—This soil is nearly level. The areas are irregular in shape and range from 10 to 80 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of Maddock and Swenoda soils. Maddock soils are on the crests of rises or very gentle undulations. Swenoda soils are intermingled with Embden soils in some areas.

This Embden soil takes in water readily, is easy to work, and has moderate or high available water capacity.

Many areas of this soil are cultivated. The soil is well suited to irrigation, but it blows easily. Controlling soil blowing is the main concern of management. Capability unit IIIe–7; Sandy range site; windbreak group 1.

Embden fine sandy loam, 2 to 6 percent slopes (EmB).—This soil is gently undulating. Slopes are short and convex. Included in mapping were areas of Maddock soils.

Erosion and soil blowing are hazards on this Embden soil. It has good tilth, takes in water readily, and has moderate or high available water capacity.

Many areas of this soil are cultivated. Controlling erosion and soil blowing are the main concerns of management. Capability unit IIIe–8; Sandy range site; windbreak group 1.

Embden-Buse complex, 2 to 9 percent slopes (EnC).—Embden soils make up 60 percent of this complex, Buse soils 20 percent, and other soils 20 percent. These soils are gently undulating to undulating. The areas are irregular in shape and commonly are less than 60 acres in size. Embden soils are in the lower parts of the landscape and are mostly gently undulating. Buse soils are on the upper parts of the landscape where the glacial till is not mantled with wind-deposited sandy material. Stones and cobblestones are on the surface of the Buse soils in some areas, mainly on the tops of ridges and knolls.

Included with these soils in mapping were small areas of Maddock soils intermingled with Embden soils. Also included in some areas near the Buse soil is a soil that has a surface layer and a subsoil of fine sandy loam, underlain by loam or clay loam glacial till at a depth of about 20 inches.

Runoff is slow on the Embden soil but is medium on the Buse soil. Erosion and soil blowing are hazards.

More than half of the areas are in native grass and are used for hay and pasture. Small grains, flax, alfalfa, and tame grasses are the main crops in cultivated areas. Controlling soil blowing and erosion are the main concerns of management. Capability unit IIIe–8; Embden soils are in Sandy range site and windbreak group 1; Buse soils are in Thin Upland range site and windbreak group 8.

Estelline Series

The Estelline series consists of nearly level, well-drained, silty soils that formed in silty material over sand and gravel. These soils are moderately deep over sand and gravel. They are on uplands.

In a representative profile the surface layer is dark-gray silt loam about 8 inches thick. The subsoil is silt loam about 22 inches thick. It is dark grayish brown and brown in the upper part and light gray in the lower part. It is slightly hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material is calcareous, pale-brown sand and gravel.

Fertility is medium in Estelline soils. Available water capacity is moderate. Permeability is moderate in the surface layer and subsoil and rapid in the underlying sand and gravel.

Many areas are cultivated. Other areas are in native grass and are used for hay and pasture.

Representative profile of Estelline silt loam, 0 to 2 percent slopes, in a cultivated area, 680 feet west and 140 feet north of the southeast corner of sec. 29, T. 126 N., R. 57 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—6 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, coarse, blocky structure parting to moderate, medium, granular structure; soft, friable; neutral; clear, wavy boundary.

B21—8 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, prismatic structure parting to weak, medium and coarse, subangular blocky structure; slightly hard, friable; thin, patchy, shiny surfaces on peds; neutral; gradual, wavy boundary.

B22—16 to 20 inches, brown (10YR 5/3) silt loam, very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; moderate, coarse and medium, prismatic structure parting to weak, coarse and medium, subangular blocky structure; slightly hard, friable; thin, patchy, shiny coats on peds; neutral; abrupt, wavy boundary.

B3ca—20 to 30 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; weak, coarse, prismatic structure parting to very weak, medium, subangular blocky structure; slightly hard, friable; common fine and medium segregations of lime; strong effervescence; moderately alkaline; abrupt, wavy boundary.

IIC—30 to 60 inches, pale-brown (10YR 6/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; strong effervescence; moderately alkaline.

The A horizon is dark gray or very dark gray. It ranges from 6 to 8 inches in thickness.

In places a C1ca horizon is present. Pebbles in the IIC horizon are commonly coated with lime. The solum ranges from 24 to 36 inches in thickness. Depth to loose sand and gravel ranges from 30 to 40 inches.

Estelline soils are similar to Fordville soils and are near Kranzburg soils. They contain less sand and are more silty than fordville soils. They differ from Kranzburg soils by having sand and gravel at a depth of less than 40 inches.

Estelline silt loam, 0 to 2 percent slopes (EsA).—This soil is nearly level. Areas are irregular in shape, and most of them are less than 40 acres in size.

Included with this soil in mapping were small areas of Kranzburg soils in areas where glacial till is the underlying material instead of sand and gravel.

Fertility is medium in this Estelline soil. Tilth is good. This soil is somewhat droughty because of the underlying sand and gravel. Available water capacity is moderate.

This soil is well suited to most crops commonly grown in the county. Conserving moisture is the main concern

of management. Capability unit IIIs–2; Silty range site; windbreak group 6.

Exline Series

The Exline series consists of deep, nearly level, somewhat poorly drained silty soils that formed in glacial lacustrine deposits. These soils have a claypan subsoil. They are in slight depressions in basins on uplands.

In a representative profile the surface layer is dark-gray silt loam about 2 inches thick. Below this is a subsurface layer of gray silt loam about 2 inches thick. The subsoil is silty clay about 15 inches thick. It is dark gray in the upper part and grayish brown in the lower part. It is hard to very hard when dry and firm when moist. Visible salts are in the lower part. The underlying material is calcareous silty clay that contains visible salts.

Fertility is low in Exline soils. Available water capacity is low or moderate. Permeability is very slow. The water table is generally below a depth of 5 feet but rises to a depth of about 4 feet in some years. Tilth is poor.

Many areas are cultivated, but the soil is better suited to pasture and hay.

Representative profile of Exline silt loam in an area of Exline-Aberdeen silty clay loams, 0 to 2 percent slopes, 2,600 feet east and 75 feet south of the northwest corner of sec. 4, T. 125 N., R. 58 W.:

A1—0 to 2 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine, granular structure; soft, friable; neutral; clear, smooth boundary.

A2—2 to 4 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; moderate, very fine, platy structure; soft, friable; neutral; abrupt, smooth boundary.

B21t—4 to 6 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; strong, coarse and medium, columnar structure parting to strong, fine and very fine, blocky structure; firm, sticky, plastic; thin continuous clay films; moderately alkaline; clear, smooth, boundary.

B22t—6 to 11 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; moderate, medium, prismatic structure parting to strong, fine and very fine, blocky structure; very hard, firm, sticky, plastic; thin, continuous clay films; strongly alkaline; clear, smooth boundary.

B3sa—11 to 19 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to strong, fine and very fine, blocky structure; hard, firm, sticky, plastic; thin continuous clay films; many fine and medium nests of salt crystals; moderately alkaline; abrupt, wavy boundary.

C1casa—19 to 30 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, fine, subangular blocky structure; hard, firm, sticky, plastic; thin, patchy, shiny surfaces on peds; few fine tongues of black; common fine and medium nests of salt crystals; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2ca—30 to 52 inches, light-gray (2.5Y 7/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, firm, sticky, plastic; few fine tongues of black; few fine nests of salt crystals; few medium segregations of lime; strong effervescence; strongly alkaline; gradual, smooth boundary.

C3cacs—52 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; common, fine, faint mottles of reddish yellow (7.5YR 6/6) and gray (5Y 5/1) moist; massive; very hard, firm, sticky, plastic; common coarse nests of gypsum crystals; few medium segregations of lime; strongly alkaline.

The A horizon typically is silt loam, but it is silty clay loam in cultivated areas. In some cultivated areas the only evidence of an A2 horizon is a gray coating on the rounded tops of the columns in the B2t horizon. The combined thickness of the A1 and A2 horizons ranges from 2 to 5 inches.

The B2t horizon is silty clay or clay and has a clay content ranging from 40 to 55 percent. Depth to visible segregations of salts ranges from 7 to 16 inches.

Exline soils are mapped with Aberdeen soils and are near Harmony soils. They have a thinner A horizon than Aberdeen soils. Their B horizon contains more sodium and other salts than does the B horizon of the better drained Harmony soils.

Exline-Aberdeen silty clay loams, 0 to 2 percent slopes (ExA).—Exline soils make up 55 percent of this complex and Aberdeen soils 45 percent. These soils are nearly level. The areas are irregular in shape and are mostly less than 40 acres in size. The Exline soils are in slight depressions. The soil that has the profile described as representative of the Exline series is in this complex. In cultivated areas the plow layer of the Exline soil is silty clay loam. Aberdeen soils are on very slight rises between the depressions.

Included with these soils in mapping were areas of Colvin and Harmony soils. Colvin soils are in some of the depressions, and Harmony soils are on some of the rises.

These Exline and Aberdeen soils are slow to dry out in spring and have poor tilth, especially the Exline soils. The dense claypan subsoil of the Exline soil is especially restrictive to the development of plant roots. Salts are concentrated at depths of less than 16 inches in Exline soils and commonly are at depths between 20 and 30 inches in Aberdeen soils.

About half of the areas of these soils are cultivated only because they are in small areas that are within larger areas suited to cultivation. In many areas these soils are better suited to pasture or hay than to other uses. Areas of this complex are not suited to irrigation. Capability unit VIs–1; Exline soils are in Thin Claypan range site and windbreak group 10; Aberdeen soils are in Clayey range site and windbreak group 4.

Fordville Series

The Fordville series consists of nearly level to undulating, well-drained, loamy soils. These soils formed in loamy material that is moderately deep over sand and gravel (fig. 12). They are on uplands.

In a representative profile the surface layer is dark-gray loam about 7 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and pale brown in the lower part. It is soft when dry and friable when moist. The underlying material, to a depth of 25 inches, is calcareous, pale-brown loam. Below this is calcareous sand and gravel.

Fordville soils are medium in fertility and have low to moderate available water capacity. Permeability is moderate in the surface layer and subsoil and rapid in the underlying material.

Many areas are cultivated. Other areas are in native grass and are used for hay and pasture.

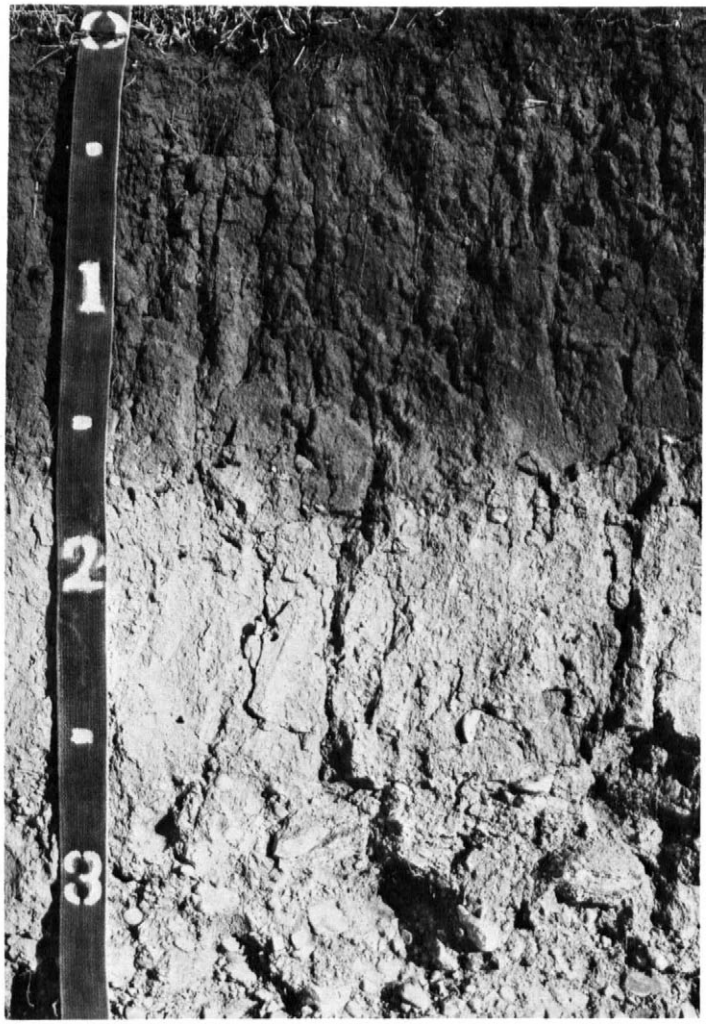

Figure 12.—**Sand and gravel is at a moderate depth in a profile of Fordville loam.**

Representative profile of Fordville loam in an area of Renshaw-Fordville loams, 860 feet south and 80 feet east of the northwest corner of sec. 33, T. 125 N., R. 53 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, medium and fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B21—7 to 10 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, coarse and medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

B22—10 to 17 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, prismatic structure parting to moderate, medium, subangular blocky structure; soft, friable; neutral; clear, smooth boundary.

B3—17 to 22 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 3/3) crushing to (10YR 4/3) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; soft, friable; neutral; abrupt, wavy boundary.

C1ca—22 to 25 inches, pale-brown (10YR 6/3) light loam, dark brown (10YR 4/3) moist; massive; soft, friable; few fine segregations of lime; strong effervescence; mildly alkaline; clear, wavy boundary.

IIC2—25 to 60 inches, pale-brown (10YR 6/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; strong effervescence; mildly alkaline.

The A horizon is very dark gray or dark gray. It ranges from 6 to 9 inches in thickness.

The B2 horizon ranges from very dark gray to brown. It has weak or moderate structure. The B3 and C horizons range from dark grayish brown to pale brown in hue of 10YR or 2.5Y. A weakly to moderately expressed horizon of lime accumulation commonly is in the B3 or C horizon in many places. Depth to sand and gravel ranges from 20 to 36 inches.

Fordville soils are mapped with Renshaw soils and are near Arvilla and Sioux soils. They are similar to Estelline soils. They contain less sand than Arvilla soils and less silt than Estelline soils. They are deeper over sand and gravel than Renshaw and Sioux soils.

Fordville loam, 0 to 2 percent slopes (FoA).—This soil is nearly level. The areas are irregular in shape and are mostly less than 40 acres in size. This soil has a profile similar to the one described as representative for the series, except that the surface layer is slightly thicker.

Included with this soil in mapping were areas of Renshaw soils that are less than 20 inches deep over gravel.

This Fordville soil has good tilth and takes in water readily, but it is somewhat droughty. Runoff is slow.

Many areas of this soil are cultivated. Small grains, flax, and alfalfa are the main crops. Conserving moisture is the main concern of management. This soil is well suited to irrigation. Capability unit IIIs–2; Silty range site; windbreak group 6.

Fordville loam, 2 to 6 percent slopes (FoB).—This soil is gently sloping and gently undulating. The areas are irregular in shape and range from 5 to 40 acres in size. The range of depth to sand and gravel is wider in the areas of gently undulating soils than it is in the areas of gently sloping soils where slopes are more uniform.

Included with this soil in mapping were areas of Renshaw and Sioux soils. Renshaw soils are intermingled with the Fordville soils. Sioux soils are on the tops of the ridges and knolls.

Runoff is medium on this Fordville soil. Erosion and soil blowing are hazards. The soil is somewhat droughty.

Many areas are cultivated. Small grains, flax, and alfalfa are the main crops. Controlling erosion is the main concern of management. This soil is well suited to irrigation. Capability unit IIIe–6; Silty range site; windbreak group 6.

Forman Series

The Forman series consists of deep, nearly level to steep, well-drained loamy soils that formed in glacial till of calcareous clay loam. These soils are on uplands.

In a representative profile (fig. 13) the surface layer is dark-gray loam about 8 inches thick. The subsoil is about 12 inches thick. It is dark-gray and very dark grayish-brown loam in the upper part and brown clay loam in the lower part. The upper part is slightly hard when dry and friable when moist. The underlying material is calcareous, pale-yellow clay loam.

Fertility is medium or high in Forman soils. Available water capacity is high. Permeability is moderate in the

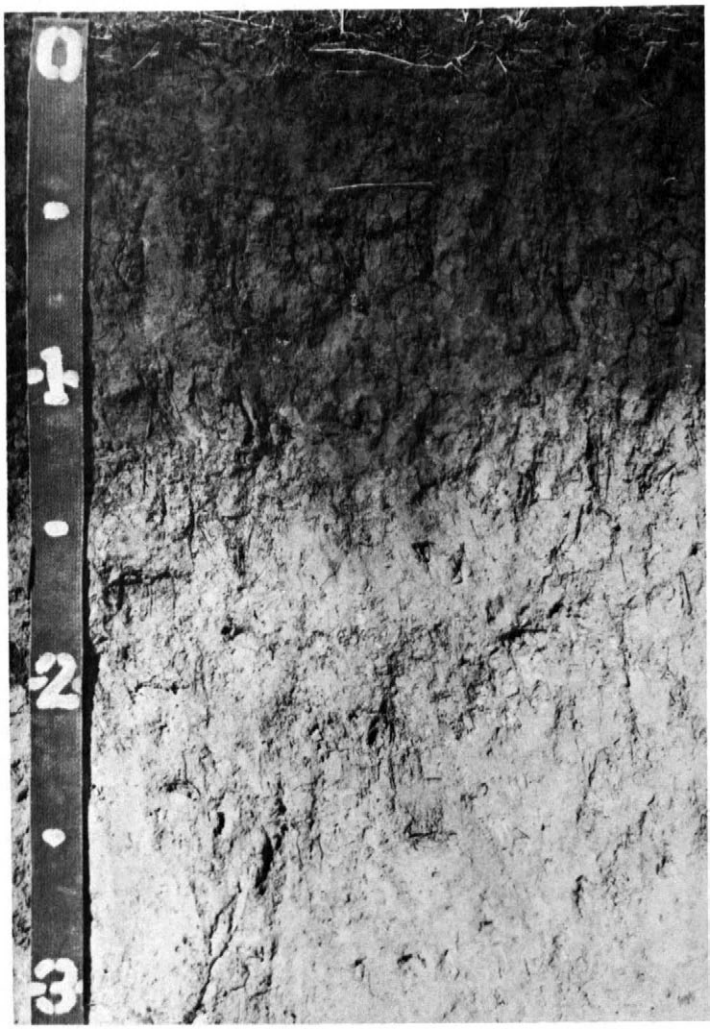

Figure 13.—**Profile of Forman loam.**

surface layer and subsoil and moderately slow in the underlying material.

The more gently sloping areas of these soils are mostly cultivated. Many sloping to steep areas are in native grass and are used for hay and pasture.

Representative profile of Forman loam in an area of Forman-Aastad loams, 6 to 9 percent slopes, 400 feet west and 200 feet north of the southeast corner of sec. 28, T. 128 N., R. 54 W.:

A1—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine, granular structure; soft, friable; neutral; clear, smooth boundary.

B21t—8 to 13 inches, dark-gray (10YR 4/1) and very dark grayish-brown (10YR 3/2) loam, black (10YR 2/1) and very dark brown (10YR 2/2) moist; moderate, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; thin, patchy, shiny faces on peds; common thin tongues of material from A1 horizon; mildly alkaline; gradual, smooth boundary.

B22t—13 to 20 inches, brown (10YR 5/3) crushing to pale-brown (10YR 6/3) clay loam, very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) crushing to dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; thin, continuous, shiny surfaces on peds; few thin tongues of material from A1 horizon; mildly alkaline; abrupt, wavy boundary.

C1ca—20 to 31 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; few, fine, distinct mottles of strong brown (7.5YR 5/8) moist; massive; hard, firm, slightly sticky, slightly plastic; common fine segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2ca—31 to 60 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; common, fine, prominent mottles of strong brown (7.5YR 5/8), yellowish red (5Y 4/8), and gray (5Y 5/1) moist; massive; hard, firm, slightly sticky, slightly plastic; few fine segregations of salt crystals; common fine segregations of lime; strong effervescence; moderately alkaline.

The A horizon is dark gray or very dark gray. It commonly is loam but in places is clay loam or silt loam. It ranges from 5 to 10 inches in thickness.

The B2t horizon ranges from very dark gray to brown in hue of 10YR. The prismatic structure is moderate or strong. The combined thickness of the A and B horizons ranges from 12 to 25 inches.

The C horizon is clay loam or loam. In places the underlying glacial till contains pockets of gravelly or sandy material.

Forman soils are associated with Aastad, Buse, and Poinsett soils. They have a thinner A horizon and are better drained than Aastad soils. Forman soils have a thicker A horizon than Buse soils and, unlike the Buse soils, they have a B2t horizon. They are less silty than Poinsett soils. Forman soils contain less clay in the B horizon than the nearby Peever soils.

Forman-Aastad loams, 0 to 2 percent slopes (FrA).—Forman soils make up 60 percent of this complex, Aastad soils 25 percent, and other soils 15 percent. These soils are nearly level. Areas are irregular in shape and are mostly less than 20 acres in size. Forman soils are on the very slight rises, and Aastad soils are in slightly depressed areas.

Included with these soils in mapping were areas of Parnell, Peever, Sinai, and Tonka soils. Parnell and Tonka soils are in small potholes. Peever and Sinai soils are on some of the very slight rises.

Runoff is slow on these Forman and Aastad soils. The hazards of erosion and soil blowing are slight. The Aastad soils receive runoff from adjacent areas, and in some years farming operations are delayed in places during extended periods of wetness.

Most areas of these soils are cultivated. They are well suited to all crops commonly grown in the county. Conserving moisture is the main concern of management. Capability unit IIc–2; Forman soils are in Silty range site and windbreak group 3; Aastad soils are in Overflow range site and windbreak group 1.

Forman-Aastad loams, 2 to 6 percent slopes (FrB).—Forman soils make up 60 percent of this complex, Aastad soils 25 percent, and other soils 15 percent. These soils are gently undulating. Slopes are mostly short and convex. Forman soils are on the rises, and Aastad soils are on foot slopes and in swales. These soils have profiles similar to the ones described as representative for their respective series, except in some of the cultivated areas the Forman soil has a thinner surface layer because of erosion. Some eroded areas are clearly visible where plow-

ing has mixed the subsoil with the surface layer. Many areas have a few stones scattered on the surface.

Included with these soils in mapping were areas of Buse, Parnell, Peever, Renshaw, Sioux, and Tonka soils. Buse soils are on the tops of ridges and knolls, especially in areas in the northeastern part of the county. Parnell and Tonka soils are in small depressions. Peever soils are on some of the rises. Renshaw and Sioux soils are in spots of less than 1 acre in size where there are small pockets of sand and gravel. Also included is Marsh in small depressions.

Fertility is medium or high in these Forman and Aastad soils. Tilth is good. Runoff is medium, but the Aastad soils are wet for short periods in some years because of runoff water from adjacent soils.

Many areas of these soils are cultivated. These soils are well suited to all crops commonly grown in the county. Areas in the Sisseton Hills commonly are in native grass and are used for pasture. Controlling erosion is the main concern of management. Capability unit IIe–2 and Silty range site; Forman soils are in windbreak group 3; Aastad soils are in windbreak group 1.

Forman-Aastad loams, 6 to 9 percent slopes (FrC).—Forman soil makes up about 60 percent of this complex, Aastad soils 25 percent, and other soils 15 percent. These soils are undulating. Areas are irregular in shape, and slopes are short and convex. A few stones are on the surface in some areas. Forman soil is on the sides and tops of the ridges. It has the profile described as representative for the series. In eroded areas it has a thinner surface layer, and in places this layer is mixed with the subsoil by plowing. Aastad soils are on foot slopes and in swales.

Included with these soils in mapping were areas of Buse, Parnell, Peever, Renshaw, Sioux, and Tonka soils. Also included are small areas of Marsh. Buse soils are on the tops of some of the ridges and knolls. Parnell and Tonka soils and Marsh are in small depressions. Peever soils are intermingled with Forman soils in some areas. Renshaw and Sioux soils are in small spots less than 1 acre in size where there are small pockets of sand and gravel.

Fertility is medium or high in these Forman and Aastad soils. Tilth is good. Runoff is medium, and the hazard of erosion is moderate.

This complex is suited to cultivation, but many areas in the Sisseton Hills are in native grass and are used for pasture. Controlling erosion is the main concern of management. Capability unit IIIe–2 and Silty range site; Forman soil is in windbreak group 3; Aastad soils are in windbreak group 1.

Forman-Aastad loams, 9 to 15 percent slopes (FrD).—Forman soils make up 55 percent of this complex, Aastad soils 25 percent, and other soils 20 percent. These soils are rolling. Many areas are on short side slopes adjacent to lakes (fig. 14) or Marsh. A few stones and cobblestones are scattered on the surface in some areas. Forman soils are on the higher parts of the landscape. These soils have a profile similar to the one described as representative for the series, except the surface layer is thinner on the upper sides of the ridges and is thicker where the soil is near Aastad soils. Eroded spots are common in cultivated fields. Aastad soils are on foot slopes and in swales. They have the profile described as representative for the series.

Figure 14.—**An area of Forman-Aastad loams, 9 to 15 percent slopes, adjacent to Island Lake.**

Included with these soils in mapping were areas of Buse, Parnell, Peever, Renshaw, Sinai, Sioux, and Tonka soils. Also included are small areas of Marsh. Of these, Buse soils are the most extensive and are on rounded hilltops. Parnell and Tonka soils and Marsh are in small potholes. Renshaw and Sioux soils are on ridges where there are small pockets of gravel. Sinai soils are on flat hilltops.

Fertility is medium or high in these Forman and Aastad soils. Runoff is medium. The hazard of erosion is severe.

Most areas of these soils are in native grass and are used for hay or pasture. A few areas are cultivated. Controlling erosion is the main concern of management. Capability unit IVe–1 and Silty range site; Forman soils are in windbreak group 3; Aastad soils are in windbreak group 1.

Forman-Buse loams, 6 to 9 percent slopes, eroded (FsC2).—Forman soils make up 55 percent of this complex, Buse soils 25 percent, and other soils 20 percent. These soils are undulating. Areas are irregular in shape and about 25 acres in size. Forman soils are on the sides of the ridges and knolls. They have a profile similar to the one described as representative for the series, except the surface layer is thinner. Buse soils are on the eroded hilltops. Their surface layer in most areas has been removed by erosion or has been mixed with the underlying material.

Included with these soils in mapping were areas of Aastad, Parnell, and Tonka soils. Aastad soils are the most extensive of these and make up as much as 20 percent of some areas. They are on foot slopes and in swales. Parnell and Tonka soils are in small potholes.

Fertility is medium or low in these Forman and Buse soils. Fertility has been further reduced by erosion. Run-

off is rapid in the eroded areas. The hazard of further erosion is severe.

The Forman soils are suited to cultivation, but the eroded Buse soils are better suited to pasture. Capability unit IVe–1; Forman soils are in Silty range site and windbreak group 3; Buse soils are in Thin Upland range site and windbreak group 10.

Forman-Buse loams, 15 to 25 percent slopes (FsE).—Forman soils make up 55 percent of this complex, Buse soils 25 percent, and other soils 20 percent. These soils are hilly. Forman soils are on the sides of the ridges and hills. They have a profile similar to the one described as representative for the series, except in the higher parts of the landscape their surface layer is thinner and the depth to lime is less. In the lower parts of the sides of the hills their surface layer is thicker. Buse soils are on the ridges and knolls. A few stones are on the surface in scattered areas.

Included with these soils in mapping were areas of Aastad, Parnell, Renshaw, Sioux, and Tonka soils. Also included were small areas of Marsh. Aastad soils are the most extensive of these. They are on foot slopes and in swales. Parnell and Tonka soils and areas of Marsh are in small potholes. Renshaw and Sioux soils are in small areas of less than 1 acre where there are pockets of sand and gravel.

Runoff is medium or rapid on these Forman and Buse soils. The hazard of erosion is very high.

These soils are not suited to cultivation. Controlling erosion is the main concern of management. Capability unit VIe–1; Forman soils are in Silty range site; Buse soils are in Thin Upland range site; both soils are in windbreak group 10.

Forman-Buse stony complex, 6 to 21 percent slopes (FtD).—Forman soils make up 55 percent of this complex, Buse soils 25 percent, and other soils 20 percent. These soils are undulating to hilly. Forman soils are on the sides of ridges and hills, and Buse soils are on ridges and knolls. Scattered through the complex, mainly on the Buse soils, are stony areas as much as 4 acres in size. The stones are as much as 5 feet in diameter and are 1 to 5 feet apart (fig. 15).

Included with these soils in mapping were areas of Aastad, Parnell, and Sioux soils. Also included were areas of Marsh. Aastad soils are the most extensive of these and make up as much as 20 percent of some areas. They are on foot slopes and in swales. Parnell soils and Marsh are in small potholes. Sioux soils are on ridgetops in places where there are small pockets of sand and gravel.

Areas of these Forman and Buse soils are too stony and, in many places, too steep for cultivation. The stones also make the areas unsuitable for hay. Most areas are used for pasture. Capability unit VIIs–6; Forman soils are in Silty range site; Buse soils are in Thin Upland range site; both soils are in windbreak group 10.

Forman-Poinsett complex, 6 to 9 percent slopes (FxC).—Forman soils make up 40 percent of this complex, Poinsett soils 25 percent, and other soils 35 percent. These soils are undulating. Areas are irregular in shape and range from 10 to 100 acres in size. Forman and Poinsett soils are on the sides of the ridges and knolls. Slopes of the Poinsett soils commonly are somewhat longer and smoother than those of the Forman soils. Both soils have profiles similar to the ones described as representative for their respective series, except eroded spots have a thinner surface layer. Also, the Forman soils in some areas are more stratified.

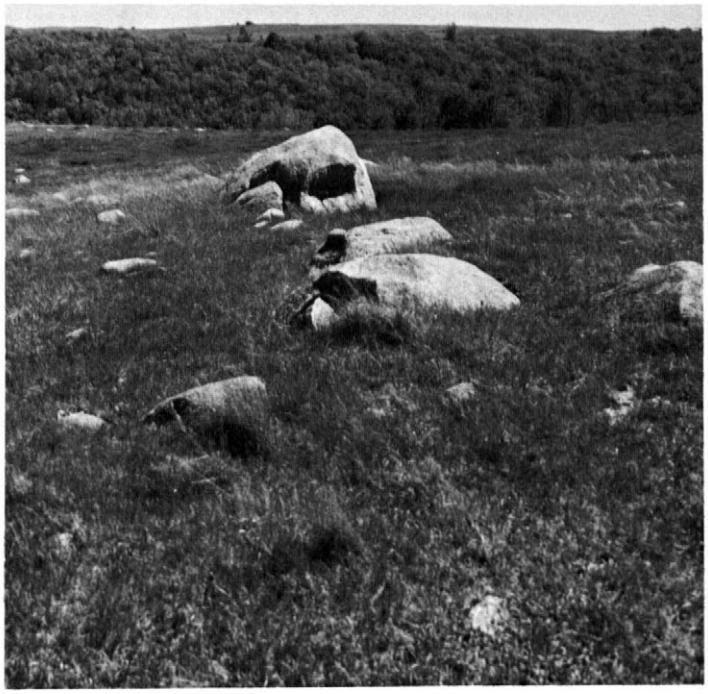

Figure 15.—Stones in an area of Forman-Buse stony complex, 6 to 21 percent slopes.

Included with these soils in mapping were areas of Buse, Parnell, Sioux, Tonka, and Waubay soils. Waubay soils are the most extensive of these and commonly make up about 15 percent of a given area. They are in swales. Buse and Sioux soils are on some of the ridges and knolls. Parnell and Tonka soils are in small potholes. Also included in areas south of Roy Lake are soils that contain more sand and less clay in their subsoil than Forman, Poinsett, and Waubay soils. They make up as much as 35 percent of some areas.

Fertility is medium or high in these Forman and Poinsett soils. Tilth is good. Runoff is medium.

Many areas of these soils are cultivated. The soils are suited to all crops commonly grown in the county. Controlling erosion is the main concern of management. Capability unit IIIe–2; Silty range site; windbreak group 3.

Forman-Poinsett complex, 9 to 15 percent slopes (FxD).—Forman soils make up 40 percent of this complex, Poinsett soils 25 percent, and other soils 35 percent. These soils are rolling. Areas are irregular in shape and range from 20 to 80 acres in size. Forman and Poinsett soils are on the sides of the ridges and hills. Slopes of the Forman soils are shorter and more convex than the smooth slopes of the Poinsett soils. Both soils have profiles similar to the ones described as representative for their respective series, except their surface layer is thinner in some areas. Eroded spots are common in culti-

vated areas. A few stones and cobblestones are scattered throughout some areas.

Included with these soils in mapping were areas of Buse, Parnell, Sioux, Tonka, and Waubay soils. Waubay soils are the most extensive of these and commonly make up 15 percent of a given area. They are in swales. Buse and Sioux soils are on the tops of ridges and knolls, and Parnell and Tonka soils are in depressions. Also included, mainly in areas south of Roy Lake, are soils that contain more sand and less clay in their subsoil than Forman, Poinsett, and Waubay soils. These soils make up as much as 35 percent of some areas.

Fertility is medium or high in these Forman and Poinsett soils. Tilth is good. Runoff is medium.

Many areas of these soils are in native grass and are used for hay and pasture. A few areas are cultivated. Controlling erosion is the main concern of management. Capability unit IVe–1; Silty range site; windbreak group 3.

Great Bend Series

The Great Bend series consists of deep, nearly level to sloping, well-drained, silty soils that formed in glacial-lacustrine deposits. These soils are on uplands.

In a representative profile the surface layer is dark-gray silt loam about 5 inches thick. The subsoil, about 9 inches thick, is dark-gray silt loam in the upper part and grayish-brown silt loam in the lower part. It is slightly hard when dry and friable when moist. The underlying material is calcareous, light-gray and white silt loam.

Fertility is medium or high in Great Bend soils. Available water capacity is high. Permeability is moderate.

Most areas of these soils are cultivated. The soils are well suited to all crops commonly grown in the county.

Representative profile of Great Bend silt loam, 2 to 6 percent slopes, in a cultivated area, 1,740 feet north and 550 feet west of the southeast corner of sec. 11, T. 127 N., R. 59 W.:

Ap—0 to 5 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, very friable; neutral, abrupt, smooth boundary.

B21—5 to 8 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky structure; slightly hard, very friable; neutral; clear, smooth boundary.

B22—8 to 14 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; weak, coarse and medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; abrupt, wavy boundary.

C1ca—14 to 22 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/3) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2ca—22 to 30 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; gradual, smooth boundary.

C3—30 to 60 inches, white (2.5Y 8/2) silt loam, light yellowish brown (2.5Y 6/4) moist; common, fine, distinct mottles of gray (N 6/0) moist; massive; slightly hard, friable, slightly plastic; slight effervescence; mildly alkaline.

The A horizon is very dark gray or dark gray. It ranges from 5 to 10 inches in thickness.

The B horizon ranges from dark gray to light yellowish brown in hue of 10YR or 2.5Y.

The C horizon is laminated silt and clay or silt, silt loam, and very fine sand. Slight or moderate amounts of salts are visible in the C horizon in places. The solum ranges from 12 to 26 inches in thickness. Texture throughout is silt loam or silty clay loam.

Great Bend soils are mapped with Beotia and Zell soils. They are similar to Kranzburg and Poinsett soils. They have thinner A and B horizons than Beotia soils. They are silty to greater depths than Kranzburg soils, which have a loamy C horizon at a depth of less than 40 inches. They contain less sand than Poinsett soils, which formed in silty glacial drift material. They differ from Zell soils in having a B horizon and in having a higher content of clay..

Great Bend silt loam, 2 to 6 percent slopes (GbB).—This soil is gently sloping. The areas range from 10 to 80 acres in size and are irregular in shape. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of Bearden, Beotia, and Zell soils. Bearden soils are in swales, and Beotia soils are on the lower parts of rises. Zell soils are on the tops of rounded ridges and knolls.

This Great Bend soil is easy to work. Fertility is medium or high. Available water capacity is high, and runoff is medium.

Nearly all areas of this soil are cultivated. Small grains, corn, flax, and hay are the main crops. Controlling erosion is the main concern of management. Capability unit IIe–1; Silty range site; windbreak group 3.

Great Bend-Beotia silt loams, 0 to 2 percent slopes (GdA).—Great Bend soils make up about 65 percent of this complex and Beotia soils 35 percent. These soils are nearly level. Great Bend soils are on slight rises. Beotia soils are commonly less sloping than Great Bend soils.

Included with these soils in mapping were areas of Bearden and Tonka soils. Bearden soils are on flats adjacent to small potholes. Tonka soils are in small potholes.

These soils are easy to work. Fertility is medium or high. Available water capacity is high, and runoff is slow. The hazard of erosion is slight.

Most areas of these soils are cultivated. They are well suited to all crops commonly grown in the county. Conserving moisture is the main concern of management. Capability unit IIc–2; Silty range site; windbreak group 3.

Great Bend-Zell silt loams, 2 to 6 percent slopes (GeB).—Great Bend soils make up 75 percent of this complex and Zell soils about 25 percent. These soils are gently undulating. In the higher parts of the areas slopes are short and convex. Great Bend soils are on the sides of knolls, and Zell soils are on the higher parts of the landscape. Both soils have profiles similar to the ones described as representative for their respective series, except the plow layer of the Zell soils has been mixed with underlying material in many of the cultivated areas.

Included with these soils in mapping were areas of Beotia soils in swales and Tonka soils in small depressions.

These soils are easy to work. Available water capacity is moderate or high. The calcareous Zell soil is low or medium in fertility. Runoff is medium on soils of this complex. The hazards of erosion and soil blowing are high on the Zell soils.

Most areas of these soils are cultivated. Controlling erosion and soil blowing are the main concerns of management. Capability unit IIe–1; Great Bend soils are in Silty range site and windbreak group 3; Zell soils are in Thin Upland range site and windbreak group 8.

Great Bend-Zell silt loams, 6 to 9 percent slopes (GeC).—Great Bend soils make up 70 percent of this complex and Zell soils 30 percent. These soils are sloping and undulating. Areas are long and narrow. These soils are on side slopes along broad drainageways. Great Bend soils are in the mid and lower parts of the areas. Zell soils are on the tops of knolls and ridges. They have a profile similar to the one described as representative for the series, except in some cultivated areas their surface layer is thinner and has been mixed with the underlying material by plowing.

Included with these soils in mapping were areas of Beotia and Embden soils on foot slopes.

These soils are easy to work. Available water capacity is moderate or high. The calcareous Zell soils are low or medium in fertility. Runoff is medium on soils of this complex. Erosion and soil blowing are hazards.

Many areas of these soils are cultivated. Controlling erosion and soil blowing is the main concern of management. Capability unit IIIe–1; Great Bend soils are in Silty range site and windbreak group 3; Zell soils are in Thin Upland range site and windbreak group 8.

Hamar Series

The Hamar series consists of deep, nearly level, poorly drained or somewhat poorly drained, sandy soils that formed in eolian sand over glacial-lacustrine material. These soils are in swales and depressions on uplands.

In a representative profile the surface layer is loamy fine sand about 23 inches thick. It is dark gray in the upper part and grayish brown in the lower part. The underlying material is grayish-brown and light-gray fine sand that has mottles of dark yellowish brown and dark gray.

Fertility is medium in Hamar soils. Available water capacity is low or moderate. Permeability is moderately rapid or rapid in the surface layer and rapid in the underlying material. A fluctuating water table is at a depth of 1 to 3 feet and seasonally is near the surface during wet years.

Many areas of these soils are cultivated. Other areas are in native grass and are used for hay or pasture.

Representative profile of Hamar loamy fine sand in native grass, 1,190 feet west and 285 feet north of the southeast corner of sec. 6, T. 128 N., R. 58 W.:

A11—0 to 16 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; very weak, medium, subangular blocky structure parting to weak, fine, granular structure; loose; very friable; mildly alkaline; gradual, smooth boundary.

A12—16 to 23 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; many, fine, distinct mottes of yellowish brown (10YR 4/4) moist; very weak, medium, subangular blocky structure; loose, very friable; mildly alkaline; gradual, wavy boundary.

C1g—23 to 28 inches, grayish-brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; common, medium, distinct mottles of yellowish brown (10YR 4/4) moist; single grained; loose; mildly alkaline; clear, smooth boundary.

C2g—28 to 40 inches, light-gray (2.5Y 7/2) fine sand, grayish brown (2.5Y 5/2) moist; common, fine, distinct mottles of dark yellowish brown (10YR 4/4) moist; single grained; loose; mildly alkaline; clear, smooth boundary.

C3g—40 to 60 inches, light-gray (2.5Y 7/2) fine sand, grayish brown (2.5Y 5/2) moist; many, medium, prominent mottles of dark yellowish brown (10YR 4/4) and dark gray (5Y 4/1) moist; single grained; loose; slight effervescence; mildly alkaline.

The A horizon ranges from very dark gray to grayish brown. It is loamy sand to fine sandy loam. This horizon ranges from 12 to 24 inches in thickness. Distinct or prominent mottles are in the lower part of the A horizon, and they are throughout the entire horizon in places.

In the C horizon mottles range from few through many, fine through coarse, and fine through prominent. In places loamy or silty material is in the C horizon at a depth of more than 40 inches. Depth to lime ranges from 30 to 60 inches or more.

Hamar soils are near Arveson, Hecla, and Ulen soils. They are more sandy, less calcareous, and not so poorly drained as Arveson soils. They have mottled colors at shallower depths and are more poorly drained than Hecla and Ulen soils. They are less calcareous than Ulen soils.

Hamar loamy fine sand (0 to 3 percent slopes) (Ha).—This soil is nearly level. Areas are irregular in shape and are mostly less than 40 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of Arveson, Hecla, and Ulen soils. Arveson soils are in depressions. Hecla and Ulen soils are on very gentle undulations.

This Hamar soil blows easily if it is cultivated. Available water capacity is low or moderate. Runoff is very slow or ponded. The water table is at a depth of 1 to 3 feet and is near the surface in wet years.

Most areas of this soil are used for hay or pasture. A few areas are cultivated, but seeding in spring is delayed in some years because of wetness. Wetness and controlling soil blowing are concerns of management. Capability unit IVw–2; Subirrigated range site; windbreak group 2.

Hamar fine sandy loam (0 to 3 percent slopes) (Hd).—This soil is nearly level. Areas are irregular in shape and are mostly less than 40 acres in size. This soil has a profile similar to the one described as representative for the series, except that the surface layer is fine sandy loam in most areas and in places loamy or silty material is at a depth of more than 40 inches.

Included with this soil in mapping were areas of Embden and Ulen soils on convex undulations.

A water table rises to a depth of less than 3 feet early in the growing season in this Hamar soil. Farming operations are delayed in some years because of wetness. Available water capacity is moderate. Runoff is slow.

Many areas of this soil are cultivated. The choice of crops is affected in some years by wetness. Capability unit IIIw–5; Subirrigated range site; windbreak group 2.

Hamerly Series

The Hamerly series consists of deep, nearly level, moderately well drained or somewhat poorly drained, cal-

careous, loamy soils that formed in calcareous glacial till. These soils are on low areas adjacent to depressions on uplands.

In a representative profile the surface layer is dark-gray loam about 9 inches thick. Below this is light-gray clay loam. These underlying materials are mottled below a depth of 21 inches.

Fertility is medium in Hamerly soils. Available water capacity is high. Permeability is moderate in the upper part of the profile and moderately slow below a depth of about 36 inches. The water table is at a depth of 3 to 4 feet early in the growing season.

Many areas are cultivated. Other areas are in native grass and are used for hay and pasture.

Hamerly soils in Marshall County are mapped only with Peever soils.

Representative profile of Hamerly loam in an area of Peever-Hamerly complex, 0 to 2 percent slopes, 1,025 feet north and 312 feet west of the southeast corner of sec. 25, T. 128 N., R. 53 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, medium, granular structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; abrupt, smooth boundary.

A12—6 to 9 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, medium, granular structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—9 to 21 inches, light-gray (2.5Y 7/2) light clay loam, grayish brown (2.5Y 5/2) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; few fine and medium segregations of lime; violent effervescence; strongly alkaline; gradual, wavy boundary.

C2ca—21 to 36 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; common, fine and medium, distinct mottles of yellowish brown (10YR 5/6) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; few fine and medium segregations of lime; violent effervescence; strongly alkaline; gradual, wavy boundary.

C3—36 to 48 inches, light-gray (2.5 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; many, fine and medium, distinct mottles of yellowish brown (10YR 5/6) and common, fine and medium, distinct mottles of gray (5Y 6/1) moist; weak, medium, blocky structure; hard, firm, sticky; few medium segregations of lime; strong effervescence; strongly alkaline; gradual, wavy boundary.

C4—48 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many, fine and medium, distinct mottles of gray (5Y 6/1) moist; massive; hard, firm, sticky; few fine concretions of lime; strong effervescence; strongly alkaline.

The A horizon is black, very dark gray, or very dark grayish brown when moist. Hue is 10YR or 2.5Y. Loam is the most common texture, but this horizon is silt loam or clay loam in some areas. In some native grass areas the upper part of the A horizon is noncalcareous.

The C horizon is loam or clay loam. Mottled colors in the C horizon are at a depth of 20 inches or more.

Hamerly soils are similar to Bearden soils and are near Tonka and Vallers soils. They contain more sand and are less silty than Bearden soils. Hamerly soils are better drained, less clayey, and more calcareous than Tonka soils. They are better drained than Vallers soils, and mottled colors are at greater depths in Hamerly soils than in Vallers soils.

Harmony Series

The Harmony series consists of deep, nearly level, moderately well drained, silty soils that formed in lacustrine material. These soils are on upland flats.

In a representative profile the surface layer is dark-gray silty clay loam about 8 inches thick. The subsoil is about 20 inches thick. It is gray and grayish-brown silty clay in the upper and middle part and calcareous, grayish-brown silty clay loam in the lower part. It is hard when dry and friable when moist. The underlying material is calcareous, light-gray silty clay loam.

Fertility is medium in Harmony soils. Available water capacity is high, and permeability is moderate. The water table is at a depth of more than 4 feet.

Most areas are cultivated. These soils are well suited to all crops commonly grown in the county.

Representative profile of Harmony silty clay loam in a cultivated area of Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes, 1,200 feet east and 70 feet south of the northwest corner of sec. 6, T. 125 N., R. 58 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, medium and fine, subangular blocky structure parting to weak, medium and fine, granular structure; slightly hard, friable, slightly sticky, slightly plastic; moderately alkaline; abrupt, smooth boundary.

B21t—8 to 17 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) crushing to very dark grayish brown (10YR 3/2) moist; weak, coarse and medium, prismatic structure parting to strong, fine and very fine, blocky structure; hard, firm, sticky, plastic; medium, continuous, shiny surfaces on peds; moderately alkaline; gradual, smooth boundary.

B22t—17 to 25 inches, grayish-brown (10YR 5/2) silty clay, very dark gray (10YR 3/1) crushing to very dark grayish brown (10YR 3/2) moist; few, fine, faint mottles of dark yellowish brown (10YR 4/4) and black (10YR 2/1) moist; weak, coarse and medium, prismatic structure parting to strong, fine and very fine, blocky structure; hard, firm, sticky, plastic; medium, continuous, shiny surfaces on peds; moderately alkaline; abrupt, wavy boundary.

B3ca—25 to 28 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; common, fine, faint mottles of dark yellowish brown (10YR 4/4) and black (10YR 2/1) moist; very weak, medium, prismatic structure parting to moderate, medium and fine, blocky structure; hard, firm, sticky, plastic; thin, patchy, shiny surfaces on peds; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—28 to 40 inches, light-gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) moist; many, fine, distinct mottles of olive yellow (2.5Y 6/6) and gray (5Y 5/1) moist; laminated; hard, friable, sticky, plastic; few fine nests of gypsum crystals; few fine segregations of lime; strong effervescence; strongly alkaline; gradual, wavy boundary.

C2—40 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; many, fine, distinct mottles of olive yellow (2.5Y 6/6) and gray (5Y 5/1) moist; laminated; hard, friable, sticky, plastic; few fine nests of gypsum crystals; strong effervescence; strongly alkaline.

The A horizon is very dark gray or dark gray. It is silt loam or silty clay loam. This horizon ranges from 6 to 14 inches in thickness.

A B1 or B&A horizon is present in places. The B2t horizon ranges from dark gray to pale brown in hue of 10YR or 2.5Y. It is heavy silty clay loam or silty clay that has a clay content ranging from 35 to 50 percent. The B2t horizon has

weak or moderate, medium or coarse, prismatic structure that parts to strong, very fine through medium, blocky structure.

In places the C horizon is stratified with silt, fine sand, and clay. Segregated salts in fine nests and striations in the C horizon range from few through many. The solum ranges from 16 to 34 inches in thickness.

Harmony soils are mapped with or are near Aberdeen and Beotia soils. They are somewhat similar to Peever and Sinai soils. Harmony soils contain less sodium and are better drained than Aberdeen soils. They have a more clayey B horizon and are not so well drained as Beotia soils. Dark-colored horizons extend to a greater depth in Harmony soils than in Peever soils. Harmony soils have a more distinct contrast in texture between the A and B horizons than Sinai soils

Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes (HeA).—Harmony soils make up about 60 percent of this complex, Aberdeen soils 25 percent, and other soils 15 percent. These soils are nearly level. Areas are irregular in shape. Aberdeen soils are in the lower, flatter areas.

Included with these soils in mapping were areas of Bearden, Beotia, and Exline soils. Bearden soils are in bands around small, low spots of Exline soils. Beotia soils are on slight rises.

The Harmony soil has properties favorable to crop growth, but permeability is slow in the dense subsoil of the Aberdeen soil. In wet years these moderately well drained soils are slow to dry out, and farming operations are delayed. If cultivated when wet, these soils lose their tilth.

Nearly all areas of these soils are cultivated. Maintaining tilth is the main concern of management. The Harmony soil is suitable for irrigation, but the Aberdeen soil is not. Capability unit IIs–1; Clayey range site; windbreak group 4.

Hecla Series

The Hecla series consists of deep, nearly level to gently undulating, moderately well drained sandy soils that formed in eolian sands. These soils are on uplands.

In a representative profile the surface layer is dark-gray loamy fine sand about 27 inches thick. Below this is a transitional layer of grayish-brown loamy fine sand about 8 inches thick. The underlying material is light-gray fine sand that has mottles of reddish yellow.

Fertility is medium in Hecla soils. Available water capacity is low or moderate. Permeability is moderately rapid or rapid in the upper part of the profile and rapid in the underlying material. The water table seasonally rises to depths between 4 and 10 feet. Soil blowing is a severe hazard.

Many areas are cultivated. Other areas are in grass and are used for hay and pasture.

Representative profile of Hecla loamy fine sand in a cultivated area of Hecla-Hamar loamy fine sands, 0 to 3 percent slopes, 500 feet west and 150 feet south of the northeast corner of sec. 7, T. 128 N., R. 58 W.:

Ap—0 to 9 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; very weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—9 to 27 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; very weak, medium, subangular blocky structure parting to very weak, fine, granular structure; soft, very friable; neutral; gradual, smooth boundary.

AC—27 to 35 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; few, medium, faint mottles of yellowish brown (10YR 5/6) moist; very weak, coarse, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

C—35 to 60 inches, light-gray (2.5Y 7/2) fine sand, grayish brown (2.5Y 5/2) moist; common, fine and medium, distinct mottles of reddish yellow (7.5YR 6/6) moist; single grained; loose; neutral.

The A horizon is very dark gray or dark gray. It is loamy fine sand or loamy sand. Thickness of the A horizon or combined A and AC horizons ranges from 16 to 40 inches.

The C horizon has colors in hue of 10YR or 2.5Y. The C horizon, to a depth of 40 inches, ranges from loamy fine sand to fine sand. In places it is loam, clay loam, or silt loam below a depth of 40 inches. Mottles below a depth of 20 inches are faint through prominent. Depth to carbonates ranges from 24 to more than 60 inches.

Hecla soils are mapped with Hamar and Venlo soils and are near Embden, Maddock, and Ulen soils. They are more sandy than Embden soils and better drained than Hamar and Venlo soils. Hecla soils are not so well drained as Maddock soils, and they have a thicker A horizon. They are less calcareous than Ulen soils.

Hecla loamy fine sand, 0 to 3 percent slopes (HfA).—This nearly level to very gently undulating soil has mostly short, convex slopes. It has the profile described as representative for the series. Included in mapping were areas of Hamar soils in low spots.

Available water capacity is low or moderate, and this Hecla soil takes in water easily. It is somewhat droughty, however, and soil blowing is the main concern in management of the many cultivated areas. Capability unit IVe–9; Sands range site; windbreak group 2.

Hecla-Hamar loamy fine sands, 0 to 3 percent slopes (HhA).—Hecla soils make up about 65 percent of this complex and Hamar soils about 35 percent. These soils are nearly level to gently undulating. Hamar soils are in low spots about 3 feet below undulations.

Included with these soils in mapping were areas of Arveson, Maddock, and Ulen soils. Arveson and Ulen soils are in some of the depressions. Maddock soils are on the crests of some of the undulations.

Available water capacity is low or moderate on these Hecla and Hamar soils. These soils take in water readily. The water table fluctuates in areas of this complex, and it rises to a depth of less than 3 feet in the Hamar soils.

About half of the areas of these soils are cultivated. Controlling soil blowing is the main concern of management, but wetness also is a concern during wet years. Capability unit IVe–9; Hecla soils are in Sands range site; Hamar soils are in Subirrigated range site; both soils are in windbreak group 2.

Hecla-Venlo complex, 0 to 6 percent slopes, eroded (HvB2).—Hecla soils make up 60 percent of this complex, Venlo soils 25 percent, and other soils 15 percent. Many convex-shaped undulations or dunes rise 3 to 8 feet above the low areas, many of which are sand blowouts caused by past soil blowing. Hecla soils are on the dunes, and Venlo soils are in the low areas.

Included with this soil in mapping were areas of Hamar soils in some of the low positions or depressions.

The available water capacity is low or moderate in these Hecla and Venlo soils. These soils take in water

readily. Runoff is slow or very slow, and the Venlo soils have a high water table that is at or near the surface except during dry periods. These soils blow easily if cultivated.

All areas of this complex are now in grass, but many areas have been cultivated in the past. Controlling soil blowing and wetness on the Venlo soil are the main concerns of management. Capability unit VIe–7; Hecla soils are in Sands range site and windbreak group 2; Venlo soils are in Wet Land range site and windbreak group 10.

Kloten Series

The Kloten series consists of shallow, hilly to steep, well-drained, silty soils on uplands. They formed in a thin mantle of glacial till over bedded shale that is at a depth of 10 to 20 inches.

In a representative profile the surface layer is dark-gray silt loam about 7 inches thick. The underlying material, to a depth of 15 inches, is dark-gray and grayish-brown silty clay loam. It is slightly hard when dry and friable when moist. Below a depth of 15 inches is gray and dark-gray bedded shale.

Fertility is low in Kloten soils. Available water capacity is low or very low. Permeability is moderate above the shale, but water penetrates the shale very slowly.

All areas are in native grass and are used for pasture.

Representative profile of Kloten silt loam in an area of Kloten-Buse complex, 15 to 40 percent slopes, 1,770 feet east and 456 feet north of the southwest corner of sec. 27, T. 125 N., R. 58 W.:

A1—0 to 7 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; few fine shale chips; neutral; clear, wavy boundary.

C1—7 to 15 inches, dark-gray (10YR 4/1) and grayish-brown (10YR 5/2) silty clay loam, very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) moist; very weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky structure; slightly hard, friable; neutral; clear, wavy boundary.

IIC2—15 to 60 inches, gray (5Y 5/1) and dark-gray (5Y 4/1) bedded shale; platy; hard; plate surfaces stained with strong brown (7.5YR 5/6); neutral.

The A horizon is gray or dark-gray silt loam or loam.

The C1 horizon above the shale ranges from dark gray to grayish brown in hue of 10YR, 2.5Y, or 5Y. The C1 horizon is silty clay loam, clay loam, or loam. It commonly contains fragments of shale. Depth to bedded shale ranges from 10 to 20 inches.

Kloten soils are mapped with Buse soils and are near Edgeley soils. They differ from Buse soils in having bedded shale at shallow depths. They are shallower over shale than Edegley soils.

Kloten-Buse complex, 15 to 40 percent slopes (KbE).—Kloten soils make up 60 percent of this complex, Buse soils 20 percent, and other soils 20 percent. These soils are hilly to steep. Areas are long and narrow and commonly are less than 40 acres in size. They are on the sides of deeply entrenched drainageways. Small gullies and landslips or slides are in some areas. Kloten soils are on the mid and lower parts of the landscape, and Buse soils are on the higher parts. Buse soils have a profile similar to the one described as representative for the series, except that in places the underlying material contains chips of shale.

Included with these soils in mapping were areas of Edgeley and Kranzburg soils. Edgeley soils are near Kloten soils, and Kranzburg soils are above the Buse soils on the outer edges of the mapped areas. Also included was Loamy alluvial land on bottom lands along some of the drainageways.

Runoff is rapid on these Kloten and Buse soils. The Kloten soil has low or very low available water capacity.

All areas of this complex are in native grass and are used for pasture and wildlife habitat. Controlling erosion is the main concern of management. Capability unit VIIe–3; Thin Upland range site; windbreak group 10.

Kranzburg Series

The Kranzburg series consists of deep, nearly level to sloping, well-drained silty soils that formed in loess over glacial till. These soils are on uplands.

In a representative profile the surface layer is dark-gray silt loam about 10 inches thick. The subsoil is silt loam about 10 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. It is slightly hard when dry and friable when moist. Between depths of about 20 to 26 inches is calcareous, light brownish-gray silt loam. Below this is calcareous, light brownish-gray and light-gray clay loam.

Fertility is medium or high in Kranzburg soils. Available water capacity is high. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material.

Most areas are cultivated. These soils are well suited to all crops grown in the county.

Representative profile of Kranzburg silt loam, 0 to 2 percent slopes, 308 feet west and 270 feet north of the southeast corner of sec. 24, T. 125 N., R. 58 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; abrupt, smooth boundary.

A12—7 to 10 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; weak, coarse, subangular blocky structure parting to moderate, fine and medium, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B21—10 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B22—14 to 20 inches, grayish-brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; moderate, coarse and medium, prismatic structure parting to weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

C1ca—20 to 26 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; slight effervescence; mildly alkaline; clear, smooth boundary.

IIC2ca 26 to 34 inches, light brownish-gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; few, fine, prominent mottles of yellowish brown (10YR 5/6) and gray (5Y 5/1) moist; massive; hard, firm, sticky, slightly plastic; strong effervescence; strongly alkaline; gradual, wavy boundary.

IIC3—34 to 60 inches, light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine, prominent mottles of yellowish-red (5Y 4/8) and gray (5Y 5/1) moist; massive; hard, firm, sticky, slightly plastic; strong effervescence; strongly alkaline.

The A horizon is very dark gray or dark gray. It ranges from 4 to 12 inches in thickness.

The B horizon ranges from very dark grayish brown to grayish brown in hue of 10YR or 2.5Y. It is silt loam or light silty clay loam.

The IIC horizon is clay loam or loam. The loess ranges from 20 to 40 inches in thickness over glacial till. Depth to lime ranges from 12 to 30 inches.

Kranzburg soils are near Forman soils and are similar to Great Bend and Poinsett soils. They are more silty than Forman soils. They differ from Great Bend and Poinsett soils in having loamy till material in the C horizon at depths of less than 40 inches.

Kranzburg silt loam, 0 to 2 percent slopes (KnA).—This soil is nearly level. Most areas are less than 80 acres in size and are long and moderately wide. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of Aastad soils in swales and in slight depressions.

Runoff is slow in this Kranzburg soil. Fertility is medium or high. This soil is easy to work. It takes in water readily, and available water capacity is high.

Most areas of this soil are cultivated. This soil is suited to all the crops commonly grown in the county. Conserving moisture is the main concern of management. Capability unit IIc–2; Silty range site; windbreak group 3.

Kranzburg silt loam, 2 to 6 percent slopes (KnB).—This soil is gently sloping. The areas are irregular in shape and are mostly less than 40 acres in size.

Included with this soil in mapping were areas of Aastad soils in swales, Buse soils on crests of ridges and knolls, and Tonka soils in depressions.

Fertility is medium or high in this Kranzburg soil. Tilth is good. This soil takes in water readily, and available water capacity is high. Runoff is medium, and erosion is a hazard where slopes are long.

This soil is cultivated. It is suited to all crops commonly grown in the county. Controlling erosion is the main concern of management. Capability unit IIe–1; Silty range site; windbreak group 3.

Kranzburg silt loam, 6 to 9 percent slopes, eroded (KnC2).—This soil is sloping. Areas are long and narrow and are mostly less than 20 acres in size. Slopes are short. The surface layer is about 5 inches thick. It is commonly lighter colored than that of the soil described as representative of the series because of mixing with the subsoil by plowing. Lime is at a depth of about 12 inches. In places pebbles that have worked up from the underlying glacial till are in the profile.

Included with this soil in mapping were areas of Buse and Sioux soils on the tops of ridges and knolls where the mantle of loess is thin or absent.

Fertility is lower in this Kranzburg soil than in most Kranzburg soils because of erosion. This soil takes in water readily, and available water capacity is high. Runoff is medium, and the hazard of further erosion is high.

Most areas of this soil are cultivated. Controlling erosion is the main concern of management. Capability unit IVe–1; Silty range site; windbreak group 3.

Kranzburg-Aberdeen silt loams, 0 to 2 percent slopes (KrA).—Kranzburg soils make up 65 percent of this complex and Aberdeen soils 35 percent. Areas are irregular in shape and less than 40 acres in size. The soils are nearly level. The long slopes are broken by low spots or swales. Kranzburg soils are on the low, rounded rises. Aberdeen soils are in low areas. They have a profile similar to the one described as representative of the Aberdeen series except for a silt loam surface layer and a subsoil that contains more sand and less silt.

Included with these soils in mapping were small scabby spots similar to Exline soils. They are designated on the soil map by the symbol for scabby spots.

The Kranzburg soils in this complex have properties favorable for crop growth. The Aberdeen soils take in water slowly, have poor tilth, and are slow to dry out in spring.

The soils in this complex are cultivated. Conserving moisture and maintaining or improving tilth in the Aberdeen soil are the main concerns of management. Capability unit IIc–2; Kranzburg soils are in Silty range site and windbreak group 3; Aberdeen soils are in Clayey range site and windbreak group 4.

Kranzburg-Aberdeen silt loams, 2 to 6 percent slopes (KrB).—Kranzburg soils make up 70 percent of this complex and Aberdeen soils 30 percent. Kranzburg soils are on long, smooth rises. Aberdeen soils are in swales or low areas. They have a profile similar to that described as representative of the Aberdeen series except for a silt loam surface layer and a subsoil that contains more sand and less silt. Also, salts and lime are at more shallow depths in these Aberdeen soils, and clay loam glacial till is at a depth of 20 to 40 inches.

Included with these soils in mapping were scabby spots within the areas of Aberdeen soils. They are designated on the soil map by the symbol for scabby spots.

The Kranzburg soils have good tilth and take in water readily, but the Aberdeen soils have slow permeability and poor tilth. Runoff is medium in the Kranzburg soils, and erosion is a hazard.

Most areas of these soils are cultivated. Controlling erosion is the main concern of management, but maintaining tilth of the Aberdeen soil is also important. Capability unit IIe–1; Kranzburg soils are in Silty range site and windbreak group 3; Aberdeen soils are in Clayey range site and windbreak group 4.

Lamoure Series

The Lamoure series consists of deep, nearly level, somewhat poorly drained or poorly drained, calcareous, silty soils that formed in alluvium. These soils are on bottom lands.

In a representative profile the surface layer is very dark gray and dark-gray silty clay loam about 15 inches thick. The subsoil is gray silty clay loam about 9 inches thick. It is slightly hard when dry and friable when moist. The underlying material is mottled silty clay loam.

Fertility is medium or high in Lamoure soils. Available water capacity is high, and permeability is moderate. The water table is at a depth between 2 and 5 feet and is commonly at a depth of less than 3 feet during part of the growing season. The soils are subject to flooding.

Some areas are cultivated. Others are in native grass and are used for hay and pasture.

Representative profile of Lamoure silty clay loam in a cultivated area, 450 feet east and 186 feet north of the southwest corner of sec. 11, T. 127 N., R. 57 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; cloddy parting to weak, fine, granular structure; slightly hard, friable, slightly sticky; slight effervescence; moderately alkaline; abrupt, smooth boundary.

A12—8 to 15 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, very coarse and coarse, subangular blocky structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

B2g—15 to 24 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure parting to weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

C1g—24 to 27 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark gray (2.5Y 3/1) moist; few, fine, distinct mottles of dark brown (10YR 3/3) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2g—27 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, faint mottles of gray (5Y 5/1) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

C3g—36 to 42 inches, gray (5Y 5/1) heavy silty clay loam, very dark grayish brown (2.5Y 3/2) moist; few, fine, distinct mottles of yellowish brown (10YR 5/6) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

C4g—42 to 52 inches, gray (5Y 6/1) silty clay loam, gray (5Y 5/1) moist; many, fine, distinct mottles of light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

C5g—52 to 60 inches, gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) moist; common, fine, distinct mottles of brown (10YR 5/3) and yellowish brown (10YR 5/3) moist; massive; hard, firm, sticky, plastic; common, medium, soft masses of lime; strong effervescence; moderately alkaline.

The A horizon is silty clay loam or silt loam. In places the upper part is noncalcareous.

The B horizon is black or very dark gray when moist, and hue is 10YR through 5Y.

Mottles in the C horizon range from faint through prominent. In places sand and gravel are at a depth of more than 40 inches. The solum ranges from 24 to 34 inches in thickness.

Lamoure soils are similar to Bearden, Colvin, Ludden, Oldham, and Vallers soils. They are more poorly drained and less calcareous than Bearden soils. They are not so poorly drained as Colvin and Vallers soils, and they are less calcareous. They contain less clay than Ludden and Oldham soils.

Lamoure silty clay loam (0 to 2 percent slopes) (la).—This nearly level soil is on bottom lands. Some areas are irregular in shape. Others, along meandering stream channels, are long and narrow. In a few areas the surface layer is loam.

Included with this soil in mapping were small areas of Colvin, Dovray, and Playmoor soils. Colvin and Playmoor soils are in low areas where water collects. Dovray soils are on slightly higher areas of the bottom lands.

Fertility is medium or high in this Lamoure soil. Available water capacity is high. The content of lime is high. This soil is susceptible to soil blowing. It is subject to periods of wetness because of flooding and the rise of a fluctuating water table. Farming operations are delayed in places because of wetness.

Many of the larger areas of this soil are cultivated. Narrow areas along stream channels are in native grass and are used for pasture and hay. Wetness is the main concern of management. Capability unit IIw–2, drained, IVw–1, undrained; Subirrigated range site; windbreak group 2.

Larson Series

The Larson series consists of deep, nearly level, moderately well drained, loamy soils. They formed in lacustrine silt and fine sand that have been reworked by wind or glacial melt water. These soils have a claypan subsoil. They are on upland flats.

In a representative profile the surface layer is dark-gray loam about 8 inches thick. The subsoil, about 9 inches thick, is gray clay loam in the upper part and grayish-brown clay loam in the lower part. It is hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material, to a depth of 29 inches, is calcareous, light-gray clay loam. Below this is calcareous, pale-yellow silt loam.

Fertility is low in Larson soils. Available water capacity is high, and permeability is slow.

Most areas are cultivated. Other areas are in grass and are used for pasture or hay.

Larson soils in Marshall County are mapped only with Swenoda soils.

Representative profile of Larson loam, in an area of Swenoda-Larson complex, 0 to 2 percent slopes, 2,460 feet east and 1,050 feet south of the northwest corner of sec. 15, T. 126 N., R. 59 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; cloddy parting to weak, fine and medium, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B2t—8 to 13 inches, gray (10YR 5/1) crushing to grayish-brown (10YR 5/2) light clay loam, very dark gray (10YR 3/1) crushing to very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, columnar structure parting to moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky, plastic; few, fine, black tongues extending to a depth of 11 inches; prominent bleached sand grains coat tops and vertical faces of columns; moderate, continuous, shiny ped faces; moderately alkaline; clear, smooth boundary.

B3ca—13 to 17 inches, grayish-brown (2.5Y 5/2) light clay loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, coarse and medium, prismatic structure parting to weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky; plastic; few fine salt crystals; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C1ca—17 to 29 inches, light-gray (2.5Y 7/2) light clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few fine salt crystals; strong effervescence; moderately alkaline; clear, smooth boundary.

C2—29 to 60 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; many, medium and coarse mottles of yellowish brown (10YR 5/6) and gray (5Y 5/1) moist; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The A horizon commonly is loam but ranges from fine sandy loam to silt loam. It ranges from 6 to 10 inches in thickness. A thin A2 horizon is present in places.

The Bt horizon is light clay loam, sandy clay loam, or loam and has a clay content ranging from 24 to 35 percent. It has weak or moderate, columnar structure. The solum ranges from 14 to 30 inches in thickness.

Larson soils are similar to Aberdeen soils and are mapped with Swenoda soils. They contain less clay in the B horizon than Aberdeen soils. They contain more clay in the B horizon than Swenoda soils.

Loamy Alluvial Land

Loamy alluvial land (lo) is on bottom lands and benches along intermittent streams and drainageways. Slopes are 0 to 1 percent. Areas are long and narrow and are mostly less than 60 acres in size. Meandering channels, 4 to 10 feet deep, dissect the areas into many small parcels.

The mixed soils of this land type are commonly calcareous loams combined with lesser amounts of silt loam and clay loam. Strata of silt and lenses of sand and gravel are commonly in the profile.

Included with this land type in mapping were small areas of Aastad, Kranzburg, and Lamoure soils.

This land type is moderately well drained or somewhat poorly drained. It is subject to periods of wetness because of flooding and the rise of a fluctuating water table.

Most areas are in native grass and are used for pasture and wildlife habitat. The meandering channels make cultivation impractical. Capability unit VIw–3; Overflow range site; windbreak group 10.

Ludden Series

The Ludden series consists of deep, level, poorly drained, calcareous, clayey soils that formed in alluvium. These soils are on bottom lands and broad flats in upland valleys.

In a representative profile the surface layer is dark-gray and gray silty clay about 32 inches thick. It is very hard when dry and firm to very firm when moist. Gray clay that contains nests of gypsum crystals is at a depth of 32 inches.

Fertility is medium in Ludden soils. Available water capacity is moderate, and permeability is very slow. The water table is at a depth of 2 to 3 feet during the early part of the growing season.

Some areas are cultivated. Others are used for pasture and hay.

Representative profile of Ludden silty clay, 1,625 feet east and 150 feet south of the northwest corner of sec. 21, T. 125 N., R. 59 W.:

Ap—0 to 10 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; cloddy parting to weak, medium, granular structure; very hard, firm, very sticky, very plastic; slight effervescence; mildly alkaline; abrupt, smooth boundary.

A12—10 to 16 inches, gray (N 5/0) clay, black (10YR 2/1) moist; weak, very coarse and coarse, prismatic structure parting to moderate, coarse and medium, blocky structure; very hard, firm, very sticky, very plastic; thin, continuous, shiny surfaces on peds; few fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

A13—16 to 23 inches, gray (N 5/0) clay, very dark gray (10YR 3/1) moist; weak, coarse and very coarse, prismatic structure parting to moderate, coarse and medium, blocky structure; very hard, very firm, very sticky, very plastic; thin, continuous, shiny surfaces on peds; common, medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

A14cs—23 to 32 inches, gray (N 5/0) clay, very dark gray (10YR 3/1) moist; very weak, coarse, prismatic structure parting to moderate, fine, blocky structure; very hard, very firm, very sticky, very plastic; thin, patchy, shiny surfaces on peds; many medium nests of gypsum crystals; few fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1gcs—32 to 44 inches, gray (5Y 5/1) clay, very dark gray (5Y 3/1) moist; common, fine, faint reddish-brown mottles; weak, fine, blocky structure; very hard, very firm, very sticky, very plastic; many coarse nests of gypsum crystals; strong effervescence; strongly alkaline; gradual, wavy boundary.

C2gcs—44 to 60 inches, gray (5Y 5/1) clay, very dark gray (5Y 3/1) moist; common, fine, distinct reddish-brown mottles; massive; very hard, very firm, very sticky, very plastic; slight effervescence; few coarse nests of gypsum crystals; strongly alkaline.

The upper part of the A horizon, when moist, is black or very dark gray in hue of 10YR.

In most areas Ludden soils are moderately saline below a depth of about 24 inches. These soils are silty clay or clay to a depth of 40 inches or more.

Ludden soils are similar to Dovray and Lamoure soils Unlike Dovray soils they are calcareous throughout. Ludden soils are more clayey than Lamoure soils.

Ludden silty clay (0 to 1 percent slopes) (lu).—This soil is in areas that are irregular in shape and average about 40 acres in size. It has the profile described as representative for the series.

Included with this soil in mapping were small, higher areas of Dovray soils that are slightly better drained.

Runoff is very slow to ponded on this Ludden soil, and it takes in water very slowly. Areas are flooded in wet years. Also, this soil is wet from the rise of a fluctuating water table during the early part of the growing season. Tilth is poor.

Some areas of this soil are cultivated. Small grains, flax, and alfalfa are the main crops. Other areas are used for pasture and hay. Wetness is the main concern of management. Capability unit IIw–2, drained, IVw–1, undrained; Overflow range site; windbreak group 10.

Maddock Series

The Maddock series consists of deep, gently undulating to rolling, well-drained, sandy soils. They formed in lacustrine sand that in most areas has been reworked and redeposited by wind. These soils are on uplands.

In a representative profile the surface layer is dark-gray loamy fine sand about 12 inches thick. Below this is a thin, transitional layer of grayish-brown loamy fine sand about 3 inches thick. The underlying material is light brownish-gray fine sand.

Fertility is medium or low in Maddock soils. Available water capacity is low, and permeability is rapid. These soils are highly susceptible to blowing.

A few areas are cultivated. Most areas are in native grass and are used for pasture.

Representative profile of Maddock loamy fine sand, 2 to 6 percent slopes, 790 feet west and 100 feet north of the southeast corner of sec. 20, T. 128 N., R. 59 W.:

A1—0 to 12 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak, fine and medium, granular structure; loose; neutral; clear, wavy boundary.

AC—12 to 15 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; very weak, fine, granular structure; loose; neutral; clear, smooth boundary.

C—15 to 60 inches, light brownish-gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; neutral.

The A horizon is very dark gray, dark gray, or gray in hue of 10YR. It is loamy fine sand, fine sandy loam, or sandy loam and ranges from 10 to 16 inches in thickness.

The C horizon ranges from fine sand to loamy fine sand. Buried horizons are common at depths ranging from 30 to 60 inches.

Maddock soils are near Embden, Hecla, and Serden soils. They are more sandy than Embden soils. Maddock soils have a thinner A horizon and are better drained than Hecla soils. They have a darker colored A horizon than Serden soils.

Maddock loamy fine sand, 2 to 6 percent slopes (MaB).—This soil is gently undulating, and slopes are short and convex. It has the profile described as representative for the series.

Included with this soil in mapping were areas of Embden, Hamar, and Serden soils. Embden and Serden soils are intermingled with Maddock soils. Hamar soils are in concave swales and depressions.

This soil is easy to work; but it is droughty, and cultivated areas are subject to soil blowing if not adequately protected. Available water capacity is low.

Many areas of this soil are in native grass, but a few are cultivated. Controlling soil blowing is the main concern of management. Capability unit IVe–9; Sands range site; windbreak group 7.

Maddock loamy fine sand, 6 to 15 percent slopes (MaD)—This soil is undulating to rolling, and slopes are short and convex. It has a profile similar to the one described as representative for the series, except that in places the surface layer is either thicker or thinner because of soil blowing. Included in mapping were small areas of Serden soils.

Available water capacity is low in this Maddock soil. The soil is droughty, and it blows easily when vegetative cover is absent. It takes in water easily, and runoff is slow.

This soil is in native grass and is used for grazing. Controlling soil blowing is the main concern of management. Capability unit VIe–7; Sands range site; windbreak group 10.

Marsh

Marsh (Mr) is in flat, enclosed depressions that range from 5 to 30 acres in size. Slopes are 0 to 1 percent. The areas are wet and are periodically under water most years. Some of the more deeply entrenched areas have open water in the center most of the time. The smaller areas dry out late in summer or in fall except in wet years.

Most areas are too wet for pasture plants and have a vegetation of rushes, cattails, and sedges. These areas are better suited to wildlife habitat than to other uses. Capability unit VIIIw–1; not placed in a range site or windbreak group.

Oldham Series

The Oldham series consists of deep, level, poorly drained, calcareous, silty soils that formed in alluvium washed from adjacent sloping soils. These soils are in depressions on uplands.

In a representative profile the surface layer is dark-gray silty clay loam about 9 inches thick. The subsoil is about 21 inches of dark-gray and gray silty clay loam that has reddish-brown and olive mottles. It is hard when dry and friable when moist. The underlying material is white and light-gray silt loam. Mottles are light olive brown and yellowish brown.

Fertility is medium in Oldham soils. Available water capacity is high, and permeability is slow. A water table is at a depth of 2 to 4 feet during part of the growing season.

Some areas are cultivated. Other areas are in native grass and are used for pasture or hay.

Representative profile of Oldham silty clay loam, 500 feet east and 110 feet north of the southwest corner of sec. 34, T. 126 N., R. 59 W.:

Ap—0 to 9 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; slightly hard, friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

B2—9 to 19 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; common, fine, faint mottles of reddish brown; weak, very coarse, prismatic structure parting to weak, coarse, subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; clear, smooth boundary.

B3g—19 to 30 inches, gray (5Y 5/1) silty clay loam, very dark gray (5Y 3/1) moist; common, fine and medium, distinct mottles of olive (5Y 5/4) moist; weak, coarse, subangular blocky structure; hard, friable; few fine nests of salts; strong effervescence; moderately alkaline; gradual, smooth boundary.

C1gca—30 to 41 inches, white (5Y 8/1) silt loam, gray (5Y 6/1) moist; common, fine, distinct mottles of light olive brown (2.5Y 5/6) moist; massive; hard, friable; few fine nests of salts; strong effervescence; moderately alkaline; clear, smooth boundary.

C2gca—41 to 60 inches, light-gray (5Y 7/1) silt loam, gray (5Y 5/1) moist; many, fine and medium, distinct mottles of yellowish brown (10YR 5/6) moist; massive; hard, friable; strong effervescence; moderately alkaline.

The A horizon, when moist, is black or very dark gray in hue of 10YR, 2.5Y, or 5Y. It ranges from 8 to 14 inches in thickness.

The B horizon is silty clay loam or silty clay. Nests of salts in the B3 and C horizons range from few through many. They are mostly gypsum. Mottles in the B3 and C horizons range from few through many and from faint through prominent.

The C horizon ranges from silt loam to silty clay. In places clay loam is below a depth of 40 inches. The solum ranges from 30 to more than 50 inches in thickness. The soil is calcareous at or within a depth of 10 inches.

Oldham soils are similar to Lamoure and Ludden soils and, like Parnell soils, are in depressions. They contain more clay than Lamoure soils and less clay than Ludden soils. Unlike Parnell soils, Oldham soils are calcareous at or near the surface.

Oldham silty clay loam (0 to 1 percent slopes) (Od).—This soil is in broad depressions that have plane or slightly concave surfaces. It has the profile described as representative for the series. Areas are commonly more than 80 acres in size.

Included with this soil in mapping were areas of Bearden and Colvin soils on the outer edges of the depressions.

This Oldham soil takes in water slowly, and runoff is slow or ponded. The areas are commonly ponded in spring, and in wet years there are serious delays in farming operations. The water table is at a depth of 2 to 4 feet during part of the growing season.

In places areas of this soil are cultivated. Corn, barley, rye, and flax are the main crops in adequately drained areas. Other areas are used for hay and pasture. Wetness is the main concern of management. Capability unit IIw–3, drained and IVw–1, undrained; Overflow range site; windbreak group 2.

Oldham silty clay loam, saline (0 to 1 percent slopes) (Oh).—This soil is in closed depressions. It has few through many nests of salts in the subsoil at shallower depth than those in the profile described as representative of the series. Included in mapping were areas of Parnell soils.

This Oldham soil takes in water slowly, and it ponds if drainage is not provided. The water table remains high for longer periods during the growing season than that in the Oldham soil described as representative for the series.

Most areas of this soil are in native grass and are used for hay or pasture. Rye, barley, and flax are the main crops. Wetness is the main concern of management. Capability unit IVw–1; Wet Land range site; windbreak group 10.

Parnell Series

The Parnell series consists of deep, level, poorly drained or very poorly drained silty soils that formed in alluvium washed from adjacent soils. These soils are in depressions on uplands.

In a representative profile the surface layer is dark-gray silty clay loam about 13 inches thick. The subsoil is dark-gray silty clay about 16 inches thick. It is hard when dry and firm when moist. The underlying material is light-gray silty clay that has mottles of strong brown and gray.

Fertility is high in Parnell soils. Available water capacity is moderate or high, and permeability is slow. The water table is generally at a depth of less than 4 feet.

If adequately drained, this soil is suited to cultivation or hay. Other areas are used for pasture and wildlife habitat.

Representative profile of Parnell silty clay loam, 2,000 feet south and 100 feet east of the northwest corner of sec. 28, T. 125 N., R. 55 W.:

A11—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable, sticky, plastic; neutral; gradual, smooth boundary.

A12—6 to 13 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; few, fine, distinct mottles of strong brown (7.5YR 5/6) moist; moderate, fine and medium, granular structure; slightly hard, firm, sticky, plastic; neutral; clear, wavy boundary.

B2t—13 to 29 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) crushing to very dark gray (5Y 3/1) moist; common, fine, distinct mottles of strong brown (7.5YR 5/6) moist; weak, very coarse, prismatic structure parting to strong, very fine, blocky structure; hard, firm, very sticky, plastic; thin, continuous, shiny surfaces on peds; mildly alkaline; abrupt, wavy boundary.

C1gca—29 to 35 inches, light-gray (5Y 7/1) silty clay, olive gray (5Y 5/2) moist; common, fine, distinct mottles of strong brown (7.5YR 5/6) moist; massive; hard, firm, very sticky, plastic; slight effervescence; moderately alkaline; gradual, wavy boundary.

C2gca—35 to 60 inches, light-gray (5Y 7/1) silty clay loam, olive (5Y 5/3) moist; many, fine and medium, prominent mottles of strong brown (7.5YR 5/6) and gray (5Y 5/1) moist; massive; hard, firm, sticky, plastic; few fine nests of salts; few fine segregations of lime; strong effervescence; moderately alkaline.

The A horizon is silty clay loam or silt loam. The B horizon ranges from black to dark grayish brown in hue of 10YR, 2.5Y, or 5Y. It is heavy silty clay loam, silty clay, or clay. The B2t horizon has moderate or strong, blocky structure. Mottles in the B and C horizons are common or many and distinct or prominent. Depth to lime ranges from 28 to 60 inches or more. In places snail shells are in these soils.

Parnell soils are near Aastad, Hamerly, and Vallers soils and are located in depressions, similarly to Oldham and Tonka soils. They are more poorly drained and contain more clay in the B horizon than Aastad and Hamerly soils. Parnell soils are less calcareous than Hamerly, Oldham, and Vallers soils. They lack the distinct A2 horizon of Tonka soils.

Parnell silty clay loam (0 to 1 percent slopes) (Pa).—This soil is in flat, closed depressions. Areas are circular and less than 15 acres in size. A thin layer of peatlike, partly decomposed organic matter is on the surface in a few areas.

Included with this soil in mapping were small areas of Oldham and Vallers soils in bands around the edges of the depressions. Also included were small areas of Marsh in the center of some areas.

Permeability is slow in this Parnell soil. Areas are ponded, and the soil is commonly flooded in spring. The water table is at a depth of less than 4 feet.

If adequately drained, this soil is suited to corn, small grains, and flax. If drainage is not feasible, it is better suited to hay, pasture, or wildlife habitat than to other uses. Capability unit IIIw–2, drained and Vw–4, undrained; Wet Land range site; windbreak group 10.

Peever Series

The Peever series consists of deep, nearly level to sloping, well-drained, loamy soils that formed in clay loam glacial till. These soils are on uplands.

In a representative profile the surface layer is dark-gray clay loam about 8 inches thick, and the subsoil is

clay loam about 16 inches thick. The subsoil is dark gray and dark grayish brown in the upper part and grayish brown in the lower part. The upper part is hard when dry and firm when moist. The lower part is calcareous. The underlying material is calcareous, light brownish-gray clay loam.

Fertility is medium or high in Peever soils. Available water capacity is moderate or high. Permeability is slow.

Most areas are cultivated. These soils are well suited to all crops commonly grown in the county.

Representative profile of Peever clay loam, 0 to 2 percent slopes, 2,265 feet west and 225 feet south of the northeast corner of sec. 20, T. 128 N., R. 53 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) moist; cloddy parting to weak, fine, granular structure; soft, friable, slightly sticky; neutral; abrupt, smooth boundary.

B21t—8 to 14 inches, dark-gray (10YR 4/1) and dark grayish-brown (2.5Y 4/2) heavy clay loam, black (10YR 2/1) and very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, coarse and medium, subangular blocky structure and moderate, fine, blocky structure; hard, firm, sticky, plastic; thin, continuous, shiny surfaces on peds; neutral; clear, wavy boundary.

B22t—14 to 17 inches, grayish-brown (2.5Y 5/2) and dark grayish-brown (2.5Y 4/2) heavy clay loam, dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to strong, fine, blocky structure; hard, firm, sticky, plastic; thin, continuous, shiny surfaces on peds; common, fine and medium, very dark gray tongues; neutral; clear, wavy boundary.

B3ca—17 to 24 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse and medium, prismatic structure parting to moderate, coarse and medium, subangular blocky structure; hard, friable, sticky, plastic; common, fine, very dark grayish brown and very dark gray tongues; few fine segregations of lime; slight effervescence; mildly alkaline; gradual, wavy boundary.

C1ca—24 to 30 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many, fine, faint mottles of yellowish brown (10YR 5/6) moist; very weak, coarse, prismatic structure parting to weak, coarse and medium, subangular blocky structure; hard, firm, sticky, plastic; common medium and coarse segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—30 to 50 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many, fine, distinct mottles of yellowish brown (10YR 5/6) moist and few, fine, distinct mottles of yellowish red (5YR 5/8) and gray (5Y 5/1) moist; massive; hard, firm, sticky, plastic; few fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—50 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many, fine, distinct mottles of yellowish brown (10YR 5/8) and very dark brown (10YR 2/2) moist and common, fine, distinct mottles of yellowish red (5YR 5/8) and gray (5Y 5/1) moist; massive; hard, firm, sticky; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark gray clay loam or silty clay loam. This horizon ranges from 6 to 10 inches in thickness.

The B2t horizon is clay, silty clay, or heavy clay loam. The content of clay ranges from 35 to 50 percent. It has weak or moderate prismatic structure that parts to moderate or strong blocky and subangular blocky structure.

The C horizon is clay loam or clay. Depth to lime ranges from 13 to 26 inches.

Peever soils are similar to Forman, Harmony, and Sinai soils. They contain more clay than Forman soils. Peever soils differ from Harmony soils in having thinner horizons with colors of very dark gray or darker when moist. Difference in content of clay in the A and B horizons is greater in Peever soils than in Sinai soils.

Peever clay loam, 0 to 2 percent slopes (PeA).—This soil is nearly level. The areas are irregular in shape, and most are less than 50 acres in size. In places the surface layer and the subsoil are thicker than those described as representative for the series, but ordinarily the profiles are the same.

Included with this soil in mapping were areas of Aastad, Hamerly, Parnell, and Tonka soils. Aastad soils are in swales, and Hamerly soils are around small depressions. Parnell and Tonka soils are in small depressions.

Fertility is medium or high in this Peever soil. It takes in water slowly. Available water capacity is moderate or high, but the subsoil releases moisture slowly to plants. Tilth deteriorates if the soil is cultivated.

Most areas of this soil are cultivated. The soil is suited to all crops commonly grown in the county. Maintaining soil tilth is the main concern of management. Capability unit IIs–1; Clayey range site; windbreak group 4.

Peever clay loam, 2 to 6 percent slopes (PeB).—This soil is gently sloping. The areas are irregular in shape and are mostly less than 40 acres in size. Slopes are mostly long and smooth and have very slight undulations (fig. 16). This soil has a profile similar to the one described as representative for the series, except that in places the surface layer is silty clay loam. In eroded areas the surface layer is thinner and commonly is mixed with the subsoil by plowing.

Figure 16.—**Windrowing flax on Peever clay loam, 2 to 6 percent slopes. The long smooth slopes favor the use of large equipment.**

Included with this soil in mapping were areas of Aastad and Forman soils. Aastad soils are in swales. Forman soils are on some of the gentle undulations.

This Peever soil takes in water slowly, and the subsoil releases moisture slowly to plants. Runoff is medium, and the hazard of erosion is moderate.

Many areas of this soil are cultivated. This soil is suited to all crops commonly grown in the county. Controlling erosion is the main concern of management. Capability unit IIIe–3; Clayey range site; windbreak group 4.

Peever clay loam, 6 to 9 percent slopes (PeC).—This soil is along drainageways below the Sisseton Hills. It has a profile similar to that described as representative for the series, but the surface layer and subsoil are thinner. Slopes are mostly long and smooth. In small areas of eroded soil on knolls and ridges the surface layer and subsoil have been mixed by plowing. In places lime is at or near the surface. In some of the lower areas the surface layer is thicker.

Included with this soil in mapping were areas of Aastad soils in swales and Buse soils on some of the ridges and knolls.

This Peever soil takes in water slowly and releases moisture slowly to plants. If cultivated, it loses its tilth. Runoff is medium, and the hazard of erosion is severe.

This soil is suited to all crops commonly grown in the county. Many areas are cultivated. Controlling erosion is the main concern of management. Capability unit IVe–7; Clayey range site; windbreak group 4.

Peever-Hamerly complex, 0 to 2 percent slopes (PhA).—Peever soils make up about 50 percent of this complex, Hamerly soil 25 percent, Tonka soils 20 percent, and other soils 5 percent. These soils are nearly level. Peever soils are on very slight rises. Hamerly soil is on flat areas around depressions of Tonka soils. It has the profile described as representative for the Hamerly series. Tonka soils have a silty clay loam surface layer.

Included with these soils in mapping were areas of Aastad, Buse, and Forman soils. Aastad soils are in some of the swales. Buse and Forman soils are on very slight undulations on some of the rises. In a few places Buse soils make up as much as 15 percent of a given area.

Permeability is moderate or slow in the Peever and Hamerly soils. Runoff is slow, and water ponded on the Tonka soils delays farming operations in wet years. Hamerly soil is high in content of lime. Tilth deteriorates easily in cultivated areas of this complex. These soils blow easily.

Most areas are cultivated. Flax, barley, rye, and alfalfa are better suited to this complex than other crops. Controlling soil blowing, maintaining tilth, and controlling wetness are concerns of management. Capability unit IIe–4; Peever soils are in Clayey range site and windbreak group 4; Hamerly soil is in Silty range site and windbreak group 1.

Playmoor Series

The Playmoor series consists of deep, nearly level, poorly drained, calcareous, silty soils that formed in silty and clayey alluvium. These soils are on bottom lands.

In a representative profile the surface layer is dark-gray silty clay loam about 11 inches thick. Below this is dark-gray and gray silty clay loam that has mottles of strong brown and dark brown. Segregations of salts are throughout the profile.

Fertility is medium in Playmoor soils. Available water capacity is high, and permeability is moderately slow. These soils are subject to flooding. A water table is at a depth of 1 to 3 feet.

A few areas are cultivated. Other areas are in native grass and are used for hay or pasture.

Representative profile of Playmoor silty clay loam, 300 feet east and 140 feet north of the southwest corner of sec. 21, T. 127 N., R. 57 W.:

A1—0 to 11 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky, slightly plastic; few fine segregations of salts; strong effervescence; mildly alkaline; clear, smooth boundary.

C1gsa—11 to 18 inches, dark-gray (N/0) silty clay loam, black (N 2/0) moist; very weak, coarse, prismatic structure parting to weak, very fine, blocky structure; hard, friable, sticky, plastic; common medium segregations of salts; common medium segregations of lime; strong effervescence; moderately alkaline; wavy boundary.

C2gsa—18 to 25 inches, dark-gray (N 4/0) silty clay loam, black (N 2/0) moist; very weak, coarse, prismatic structure; hard, friable, sticky, plastic; common fine segregations of salts; strong effervescence; moderately alkaline; clear, wavy boundary.

C3gsa—25 to 37 inches, gray (5Y 5/1) silty clay loam, very dark gray (N 3/0) moist; common, fine, faint mottles of strong brown (7.5YR 5/8) and dark brown (7.5YR 3/2) moist; weak, very fine, subangular blocky structure; hard, firm, sticky, plastic common fine and medium segregations of salts; strong effervescence; moderately alkaline; clear, wavy boundary.

C4gcasa—37 to 54 inches, gray (5Y 6/1) silty clay loam, dark gray (5Y 4/1) moist; common, fine, distinct mottles of strong brown (7.5YR 5/8) and dark brown (7.5YR 3/2) moist; massive; hard, firm, sticky, plastic; common fine and medium segregations of salts; common, medium segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

C5g—54 to 60 inches, gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) moist; common, fine, distinct mottles of strong brown (7.5YR 5/8) and dark brown (7.5YR 3/2) moist; massive; hard, firm, sticky, plastic; few fine segregations of salts; few fine segregations of lime; strong effervescence; moderately alkaline.

The A horizon, when moist, is black or very dark gray in hue of 10YR or 2.5Y, or the color is neutral. It is silty clay loam or silt loam and ranges from 6 to 22 inches in thickness.

The C horizon, when moist, ranges from black to dark gray in hue of 2.5Y, 5Y, or the color is neutral. Buried A horizon commonly are in the C horizon at a depth of more than 20 inches. Mottles in the C horizon are few through many, fine or medium, and faint through prominent. Segregations of salts, carbonates, and gypsum range from few through many in the Cg horizon. Below a depth of 40 inches strata of sand, silt, or clay are in some profiles.

Playmoor soils, like Lamoure and Ludden soils, are on bottom lands. They are similar to Oldham soils. Playmoor soils contain more salts than any of these soils, and they contain less clay than Ludden and Oldham soils.

Playmoor silty clay loam (0 to 2 percent slopes) (Pm).—This soil is on bottom lands along streams and drainageways and in seep areas on uplands. Areas are mostly

long and narrow and are dissected into smaller areas by meandering channels.

Included with this soil in mapping were areas of Bearden, Dovray, and Lamoure soils in slightly higher areas.

This Playmoor soil is wet much of the time because of the high water table and flooding. Choice of crops is limited because of the salt in the soil.

Most areas of this soil are in native grass and are used for hay or pasture. A few areas are cultivated, but farming operations are delayed by wetness, and in some years crops are drowned by floodwater. Small grain, corn, and flax are the main crops. Wetness is the main concern of management. Capability unit IVw–1; Subirrigated range site; windbreak group 10.

Poinsett Series

The Poinsett series consists of deep, nearly level to rolling, well-drained, silty soils that formed in silty, glacial-drift material. These soils are on uplands.

In a representative profile the surface layer is dark-gray silt loam about 8 inches thick. The subsoil is silty clay loam about 17 inches thick. It is dark gray in the upper part, dark grayish brown in the middle part, and pale brown in the lower part. It is slightly hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material is calcareous silty clay loam. A layer of calcareous sandy loam is between depths of 41 and 47 inches.

Fertility is medium or high in Poinsett soils. Available water capacity is high. Permeability is moderate.

Many areas are cultivated. Rolling areas are commonly in native grass and are used for pasture or hay.

Representative profile of Poinsett silt loam in a cultivated area of Poinsett-Forman complex, 2 to 6 percent slopes, 2,300 feet west and 57 feet north of the southeast corner of sec. 18, T. 125 N., R. 56 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; cloddy parting to moderate, fine, granular structure; slightly hard, friable, slightly sticky; neutral; abrupt, smooth boundary.

A12—6 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, fine, granular structure; slightly hard, friable, slightly sticky; neutral; clear, wavy boundary.

B21—8 to 13 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky; thin, very patchy, shiny surfaces on peds; neutral; gradual, wavy boundary.

B22—13 to 17 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky; thin, very patchy, shiny surfaces on peds; neutral; clear, wavy boundary.

B3ca—17 to 25 inches, pale-brown (10YR 6/3) silty clay loam, yellowish brown (10YR 5/4) moist; common, fine, faint mottles of brownish yellow (10YR 6/6) moist; weak, coarse, prismatic structure parting to weak, coarse and medium, subangular blocky structure; hard, friable, slightly sticky, common fine concretions of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—25 to 41 inches, light yellowish-brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; many, fine, faint mottles of yellowish brown (10YR 5/6) moist and common, fine, distinct mottles of gray (5Y 5/1) moist; weak, coarse, subangular blocky structure; hard, friable, slightly sticky; common fine and medium concretions of lime; strong effervescence; mildly alkaline; clear, smooth boundary.

C2—41 to 47 inches, light yellowish-brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; common, fine, faint mottles of yellowish brown (10YR 5/6) moist; single grained; loose; strong effervescence; moderately alkaline; clear, smooth boundary.

C3—47 to 60 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 6/1) moist; common, fine and medium, distinct mottles of yellowish brown (10YR 5/6 & 5/8) moist; laminated; hard, friable, slightly sticky; few fine segregations of lime; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark gray. It is silt loam or silty clay loam. This horizon ranges from 6 to 12 inches in thickness.

The B horizon has dominant colors in hue of 10YR or 2.5Y. It is silt loam or silty clay loam. Mottles in the B3 and C horizons are few through many and faint or distinct. They are inherited from the glacial-drift material.

The C horizon is commonly stratified with loamy, sandy, and gravelly material at a depth of more than 40 inches. In places clay loam glacial till is at a depth between 40 and 60 inches. Depth to lime ranges from 12 to 26 inches. A few pebbles and stones are in the soil in places.

Poinsett soils are mapped with Forman and Waubay soils. They are more silty than Forman soils, and they are better drained and have a thinner B horizon than Waubay soils.

Poinsett-Forman complex, 2 to 6 percent slopes (PoB).—Poinsett soil makes up about 50 percent of this complex, Forman soil 30 percent, and other soils 20 percent. These soils are gently undulating. Areas are irregular in shape and are mostly less than 80 acres in size. Poinsett and Forman soils are closely intermingled. Poinsett soil has longer and somewhat smoother slopes than Forman soil. It has the profile described as representative for the series. In places the Forman soil has thin lenses of sand and gravel in the underlying material. Also, the surface layer is thinner on some of the ridges.

Included with these soils in mapping were areas of Buse, Parnell, Tonka, and Waubay soils. Waubay soils are the most extensive of these, making up as much as 20 percent of a given area. They are in swales. Buse soils are on some of the ridges and knolls. Parnell and Tonka soils are in small depressions. Also included in some areas were loamy soils that contain more sand than Forman, Poinsett, and Waubay soils.

Available water capacity is high in these Poinsett and Forman soils. They take in water readily. Runoff is medium, and there is some hazard of erosion. Tilth is good.

Most areas are cultivated. These soils are well suited to all crops commonly grown in the county. Controlling erosion is the main concern of management. Capability unit IIe–2; Silty range site; windbreak group 3.

Poinsett-Waubay silty clay loams, 0 to 2 percent slopes (PwA).—Poinsett soils make up about 60 percent of this complex and Waubay soils 40 percent. These soils are nearly level. Poinsett soils are on slight rises. They have a profile similar to the one described as representative for the series, except that the surface layer is silty clay loam. Waubay soils are in swales or in slight depressions. The soil that has the profile described as representative for the Waubay series is in this complex.

Included with these soils in mapping were areas of Parnell and Tonka soils in small potholes. Also included were small areas of soils around the potholes that are similar to the Poinsett soils, except that they are calcareous.

Fertility is medium or high in these Poinsett and Waubay soils. These soils are easy to work. Runoff is slow. Waubay soils receive additional moisture in the form of runoff from adjacent soils.

Most areas are cultivated. These soils are suited to all crops commonly grown in the county. Capability unit IIc–3; Silty range site; Poinsett soils are in windbreak group 3; Waubay soils are in windbreak group 1.

Poinsett-Waubay silty clay loams, 2 to 6 percent slopes (PwB).—Poinsett soils make up 60 percent of this complex, Waubay soils 25 percent, and other soils 15 percent. These soils are gently sloping. The Poinsett soils have smooth slopes. Waubay soils are in swales. The Poinsett soils have a profile similar to that described as representative for the series, except that the surface layer is silty clay loam.

Included with these soils in mapping were areas of Forman, Parnell, Sinai, and Tonka soils. Forman soils are on some of the rises. Parnell and Tonka soils are in small potholes. Sinai soils are on flat tops of ridges and knolls. Also included in some areas were loamy soils that contain less clay in the subsoil than Poinsett soils.

Available water capacity is high in these soils. They take in water readily and are easy to work. Runoff is medium, and there is some hazard of erosion.

Most areas are cultivated. These soils are suited to all crops commonly grown in the county. Capability unit IIe–1, Silty range site; Poinsett soils are in windbreak group 3; Waubay soils are in windbreak group 1.

Renshaw Series

The Renshaw series consists of nearly level to undulating, somewhat excessively drained, loamy soils that formed in glacial outwash material. These soils are shallow over sand and gravel. They are on uplands.

In a representative profile (fig. 17) the surface layer is dark-gray loam about 7 inches thick. The subsoil is dark grayish-brown loam about 10 inches thick. It is soft when dry and friable when moist. The underlying material is calcareous, brown sand and gravel.

Fertility is low in Renshaw soils. Available water capacity is low. Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying sand and gravel.

Many areas are cultivated. Other areas are in native grass and are used for grazing.

Representative profile of Renshaw loam in an area of Renshaw-Fordville loams, 0 to 3 percent slopes, 75 feet east and 95 feet south of the northwest corner of sec. 33, T. 125 N., R. 53 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, medium and fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B21—7 to 13 inches, dark grayish-brown (10YR 4/2) loam, very dark gray (10YR 3/1) crushing to very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, prismatic structure parting to weak, coarse and medium, subangular blocky structure; soft, friable; neutral; gradual, smooth boundary.

B22—13 to 17 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; moderate, coarse and medium, prismatic structure parting to weak, coarse and medium, subangular blocky structure; soft, friable; neutral; gradual, wavy boundary.

IICca—17 to 60 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; slight effervescence; mildly alkaline.

Figure 17.—**Profile of Renshaw loam.**

The A horizon is dark gray or very dark gray. It ranges from 5 to 8 inches in thickness. The B2 horizon has weak or moderate prismatic structure. Pebbles in the upper part of the IIC horizon are commonly coated with lime. Depth to sand and gravel ranges from 10 to 20 inches.

Renshaw soils are mapped with Fordville soils and are near Arvilla, Estelline, and Sioux soils. They contain less sand and more clay in the horizons above the sand and gravel than Arvilla soils. Renshaw soils are shallower over sand and gravel than Estelline and Fordville soils and deeper over sand and gravel than Sioux soils.

Renshaw-Fordville loams, 0 to 3 percent slopes (RfA).—Renshaw soils make up about 60 percent of this complex and Fordville soils 40 percent. These soils are

nearly level, except for complex slopes throughout the areas that are very gently undulating. Renshaw soils are on the rises, and Fordville soils are in the lower and more level areas. These soils have the profiles described as representative for their respective series. Included in mapping were spots of Sioux soils.

These soils take in water readily, but available water capacity is low or moderate. They are droughty. Runoff is slow in these Renshaw and Fordville soils. Tilth is good.

Many areas are cultivated. These soils are better suited to crops that mature early than to row crops, such as corn. They are suitable for irrigation. Conserving moisture is the main concern of management. Capability unit IVs–1; Renshaw soils are in Shallow to Gravel range site and windbreak group 10; Fordville soils are in Silty range site and windbreak group 6.

Renshaw-Fordville loams, 3 to 6 percent slopes (RfB).—Renshaw soils make up about 70 percent of this complex and Fordville soils 30 percent. These soils are gently sloping and gently undulating. The areas are mostly less than 40 acres in size. Renshaw soils are on the higher parts of the landscape, and Fordville soils are on the lower parts.

Included with these soils in mapping were areas of Sioux soils on the upper parts of ridges and knolls. In places the Sioux soils are stony.

These Renshaw and Fordville soils take in water readily but are droughty. Runoff is medium, and erosion and soil blowing are hazards.

Many areas are cultivated. Small grains, flax, and alfalfa are the main crops. Early maturing crops are better suited than other crops. Controlling erosion and soil blowing and conserving moisture are concerns of management. Capability unit IVe–6; Renshaw soils are in Shallow to Gravel range site and windbreak group 10; Fordville soils are in Silty range site and windbreak group 6.

Renshaw-Fordville loams, 6 to 9 percent slopes (RfC).—Renshaw soils make up 75 percent of this complex and Fordville soils 25 percent. Most of the areas are undulating, but some are sloping. Renshaw soils are on the higher parts of the landscape, and Fordville soils are on the lower parts. The Renshaw soils have a profile similar to the one described as representative for the series, except that they have a thinner surface layer and subsoil and have gravel at a depth of about 14 inches.

Included with these soils in mapping were areas of Sioux soils on the tops of some of the ridges. Also included were small stony areas.

Runoff is medium in these Renshaw and Fordville soils. These soils are droughty. The hazards of erosion and soil blowing are high.

Most areas are used for grazing. The Fordville soils are suitable for crops but are so intermingled with Renshaw soils in most areas that it is not practical to manage the Fordville soils separately. Controlling erosion is the main concern of management. Capability unit VIe–5; Renshaw soils are in Shallow to Gravel range site and windbreak group 10; Fordville soils are in Silty range site and windbreak group 6.

Sandy Lake Beaches

Sandy lake beaches (0 to 2 percent slopes) (Sa) consists of mixed soils and soil material that are mainly beach sand and gravel and have little or no soil development. Areas are long and narrow and are adjacent to lakes and marshes. The surface layer is commonly calcareous loamy fine sand but in places is dark-colored calcareous loam about 6 inches thick. The underlying material is stratified sand and gravel that is mottled. In places layers of silt and clay are at a depth of less than 40 inches.

Most areas are somewhat poorly drained or poorly drained. The level of the water table corresponds to that of the lakes and marshes. When the water level is high in the lakes and marshes the surface layer is reworked by wave action, and some areas are under water for short periods.

Vegetative cover on Sandy lake beaches ranges from barren in recently disturbed areas to a good cover of native grasses in the more stable areas. This land type is better suited to grazing and wildlife habitat than to other uses. Capability unit VIw–3; Subirrigated range site; windbreak group 10.

Serden Series

The Serden series consists of deep, nearly level to hilly, excessively drained sandy soils that formed in glacial-lacustrine sand that has been reworked and sorted by wind. These soils are on uplands.

In a representative profile the surface layer is light brownish-gray fine sand about 7 inches thick. Below the surface layer is a thin layer of grayish-brown fine sand. The underlying material is light brownish-gray fine sand. Material throughout the entire profile is loose.

Fertility is low in Serden soils. Available water capacity is low, and permeability is rapid. Organic-matter content is low or moderately low. The hazard of soil blowing is severe.

All areas are in native grass and are used for pasture or hay.

Representative profile of Serden fine sand under native grass in an area of Serden-Venlo complex, 0 to 6 percent slopes, 170 feet south and 85 feet east of the northwest corner of sec. 30, T. 128 N., R. 59 W.:

A1—0 to 7 inches, light brownish-gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; very weak, fine, granular structure parting to single grained; loose; neutral; clear, wavy boundary.

Ab—7 to 10 inches, grayish-brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) moist; very weak, fine, subangular blocky structure parting to single grained; loose; neutral; clear, wavy boundary.

C—10 to 60 inches, light brownish-gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; neutral.

The A horizon ranges from dark gray to pale brown. One or more thin, buried A horizons is generally in the profile. The C horizon ranges from grayish brown to pale brown or light gray in hue of 10YR or 2.5Y. In places this horizon is calcareous below a depth of 40 inches. Texture throughout the profile is fine sand or loamy fine sand.

Serden soils are mapped with Venlo soils and are near Hamar, Hecla, and Maddock soils. They have a thinner and commonly lighter colored A horizon than these soils. They

are better drained than Hamar, Hecla, and Venlo soils and lack mottles at depths of less than 40 inches.

Serden fine sand, 6 to 21 percent slopes, eroded (SdD2).—This soil is undulating to hilly. Slopes are short and rounded, except where they are broken by active sand blowouts, which are scattered throughout the areas (fig. 18). Elevation in the areas varies as much as 30 feet. This soil has a profile similar to the one described as representative for the series, except that the areas near the blowouts have recently deposited sand on the surface. The blowouts range from 10 to 300 feet in diameter, and are mostly on the crests of ridges and knolls.

Fertility is low in this Serden soil. It takes in water easily, but available water capacity is low.

All areas are in native grasses and are used for grazing. The soil blows easily, and controlling soil blowing is the main concern of management. Capability unit VIe–7; Sands range site; windbreak group 10.

Serden-Venlo complex, 0 to 6 percent slopes (SeB).—Serden soils make up about 55 percent of this complex and Venlo soils 45 percent. These soils are nearly level to gently sloping. Areas are irregular in shape and are mostly more than 100 acres in size. Surface relief of the landscape is uneven, and many low areas are interspersed between gentle undulations. Serden soils are on the undulations, and Venlo soils are in the low areas, many of which are stabilized sand blowouts (fig. 19). Serden soils have the profile described as representative for the series. Venlo soils have a profile similar to that described as representative for the Venlo series, but in places the surface layer is thinner. A few small, active blowouts are in some areas.

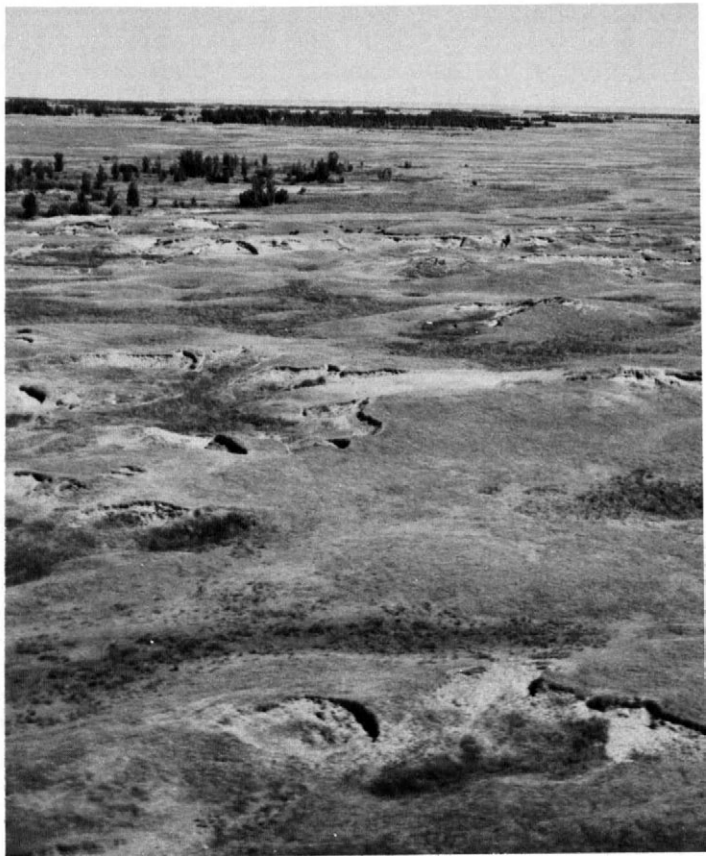

Figure 18.—Sand blowouts in an area of Serden fine sand, 6 to 21 percent slopes, eroded.

Figure 19.—Area of Serden-Venlo complex, 0 to 6 percent slopes.

Included with these soils in mapping were areas of Arveson, Hamar, and Maddock soils. Arveson and Hamar soils are in some low areas. Maddock soils are on some of the undulations.

Serden soils are excessively drained, but Venlo soils are very poorly drained and have a water table near the surface. Both soils blow easily.

All areas are in native grass and are used for grazing. Controlling soil blowing is the main concern of management, but controlling wetness on the Venlo soils is also important. Capability unit VIe–7; Serden soils are in Sands range site; Venlo soils are in Wet Land range site; both soils are in windbreak group 10.

Sieche Series

The Sieche series consists of deep, sloping to steep, well-drained, loamy soils that formed in clay loam glacial till. These soils are on uplands.

In a representative profile about 1 inch of matted leaves and partly decomposed organic matter is above the surface layer. The surface layer is very dark gray loam and clay loam about 20 inches thick. Below this is a transitional layer of gray and dark-gray clay loam about 4 inches thick. The subsoil, about 17 inches thick, is grayish-brown clay in the upper part and calcareous, light brownish-gray clay loam in the lower part. The upper part is very hard when dry and firm when moist. The underlying material is calcareous, light-gray clay loam.

Fertility is medium or high in Sieche soils. Available water capacity is high, and permeability is moderate.

All areas are in native vegetation of trees and an understory of grass and shrubs.

Representative profile of Sieche loam, 21 to 50 percent slopes, in native woodland, 2,100 feet east and 200 feet north of the southwest corner of sec. 29, T. 128 N., R. 53 W.:

O1—1 inch to 0, very dark-gray (10YR 3/1) and black (10YR 2/1) matted leaves and partly decomposed organic matter.

A11—0 to 6 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate, fine, subangular blocky structure parting to weak, fine, granular structure; slightly hard, very friable; neutral; clear, wavy boundary.

A12—6 to 15 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak, coarse and medium, subangular blocky structure parting to weak, very fine, granular structure; slightly hard, very friable; slightly acid; clear, wavy boundary.

A13—15 to 20 inches, very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky; slightly acid; clear, wavy boundary.

B&A—20 to 24 inches, gray (10YR 5/1) and dark-gray (10YR 4/1) clay loam (B part), black (10YR 2/1) moist, and light-gray (10YR 7/1) bleached sand grains (A part), dark gray (10YR 4/1) moist; moderate, medium and fine, subangular blocky structure; neutral; clear, wavy boundary.

B2t—24 to 32 inches, grayish-brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; weak, medium. prismatic structure parting to moderate, coarse and medium, blocky structure; very hard, firm, sticky and plastic; few bleached sand grains and pockets of gray (10YR 5/1) moist coatings on upper 2 inches of peds; thin, continuous clay films; neutral; clear, wavy boundary.

B3ca—32 to 41 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; when moist has common, fine, distinct mottles of olive yellow (2.5Y 6/6) and few, fine, distinct mottles of yellow red (5YR 4/6) and few, fine and medium, distinct mottles of gray (5Y 5/1); moderate, coarse and medium, subangular blocky structure; hard, firm, sticky and plastic; few coarse segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1—41 to 60 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; few, fine and medium, distinct mottles of gray (5Y 5/1) and yellowish red (5YR 4/6) moist; weak, coarse, subangular blocky structure; hard, firm, sticky; strong effervescence; moderately alkaline.

The A1 horizon is very dark gray or dark gray. Texture is loam or clay loam. Thickness ranges from 9 to 22 inches. The B&A horizon is not present in places.

The B2t horizon ranges from grayish brown to pale brown. It is clay loam or clay. This horizon has moderate or strong blocky secondary structure. Bleached sand grains in the upper part of the B2t horizon are few to common. Segregations of lime in the B3ca horizon are few or common and fine through coarse. Depth to carbonates ranges from 23 to 40 inches.

Sieche soils are near Aastad, Forman, and Peever soils. They contain more clay in the B horizon than Aastad and Forman soils. Sieche soils have a thicker A horizon than Peever soils.

Sieche loam, 6 to 15 percent slopes (ShD).—This sloping to strongly sloping soil is on the eastern side of the Sisseton Hills and around some of the larger lakes. The areas are long and narrow. This soil has a profile similar to the one described as representative for the series, but more stones and other coarse materials are in the soil in the areas around the lakes.

Included with this soil in mapping were areas of Aastad, Buse, and Forman soils. Aastad soils are in swales. Buse and Forman soils are on the higher parts of the landscape that are in native grass. Also included were areas of Loamy alluvial land on the bottom of draws.

Fertility is medium or high in this Sieche soil. Available water capacity is high. Runoff is medium, and erosion is a hazard if the vegetative cover is removed.

All areas are in native woodland and have an understory of grasses and shrubs. Controlling erosion is the main concern of management. Capability unit IVe–1; not placed in a range site; windbreak group 4.

Sieche loam, 21 to 50 percent slopes (ShF).—This hilly to very steep soil is on the sides of wooded coulees or drainageways on the eastern side of the Sisseton Hills (fig. 20). Areas are long and are more than 100 acres in size. This soil has the profile described as representative for the series, but in places the dark-colored surface layer is about 3 inches thick and there is a light-gray subsurface layer. Such places are most common in heavily wooded areas on north-facing slopes or in the lower parts of the landscape. They make up about 20 percent of a given area.

Included with this soil in mapping were areas of Buse soils on the rims of the coulees and Forman soils in grassed areas or where there are thin stands of trees. Also included were areas of Loamy alluvial land along drainageways on the bottoms of the coulees.

Runoff is rapid in this Sieche soil. The hazard of erosion is high where vegetation is missing.

All areas are in native trees, and these wooden areas have only a sparse understory of grasses. Some of the trees are cut for timber that is used locally for posts and poles. Grazing use is limited by the sparse cover of grass. This soil is too steep to be cultivated. Capability unit VIIe–1; not placed in a range site; windbreak group 10.

Figure 20.—**An area of Sieche loam, 21 to 50 percent slopes, on the sides of a wooded coulee.**

Sinai Series

The Sinai series consists of deep, nearly level to sloping, well-drained, clayey soils that formed in glacial-lacustrine deposits. These soils are on uplands.

In a representative profile the surface layer is dark-gray silty clay about 8 inches thick. The subsoil, about 20 inches thick, is dark-gray silty clay in the upper part and grayish-brown, calcareous silty clay in the lower part. It is hard when dry and firm when moist. The underlying material is calcareous, light-gray silty clay to a depth of 50 inches. Below this is silty clay loam.

Fertility is high in Sinai soils. Available water capacity is moderate or high. Permeability is slow. If cultivated, these soils tend to lose their tilth.

Most areas are cultivated. A few areas are in native grass and are used for pasture or hay.

Representative profile of Sinai silty clay, 3 to 6 percent slopes, 1,670 feet east and 210 feet north of the southwest corner of sec. 28, T. 125 N., R. 55 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; cloddy parting to moderate, very fine and fine, granular structure; slightly hard, friable, sticky, plastic; neutral; abrupt, smooth boundary.

B2—8 to 19 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) crushing to very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure parting to moderate, coarse and medium, subangular blocky structure that in turn parts to strong, very fine, blocky structure; hard, firm, sticky, plastic; mildly alkaline; abrupt, wavy boundary.

B3ca—19 to 28 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, coarse and medium, subangular blocky structure parting to moderate, very fine, blocky structure; hard, firm, sticky, plastic; few fine tongues of black (10YR 2/1) moist; few fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—28 to 50 inches, light-gray (2.5Y 7/2) silty clay, light olive brown (2.5Y 5/4) moist; common, fine, distinct mottles of yellowish red (5YR 4/6) and gray (5Y 5/1) moist; massive; hard, firm, sticky, plastic; few pressure faces; few fine segregations of lime; strong effervescence; strongly alkaline; gradual, wavy boundary.

C2—50 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) moist; many fine and medium, prominent mottles of yellowish red (5YR 4/6) and gray (5Y 5/1) moist; laminated; hard, firm, sticky, plastic; few pressure faces; strong effervescence; strongly alkaline.

The A horizon is dark-gray or very dark gray silty clay or silty clay loam. It ranges from 5 to 10 inches in thickness.

The B2 horizon ranges from very dark gray to light brownish gray or pale brown in hue of 10YR or 2.5Y. It is silty clay or clay.

The C horizon is commonly silty clay, clay, or silty clay loam. Mottles in the C horizon range from few through many. Depth to carbonates ranges from 12 to 26 inches.

Sinai soils are near Poinsett and Waubay soils and are similar to Peever soils. They are more clayey than Poinsett and Waubay soils. In Sinai soils the A and B horizons are less contrasting in content of clay than those in Peever soils.

Sinai silty clay, 0 to 3 percent slopes (SkA).—This nearly level soil is on mesalike hilltops on uplands. Areas are circular in shape and range from 5 to 40 acres in size. Small areas have slopes of more than 3 percent. Slopes are long and uniform in the larger areas.

Fertility is high in this Sinai soil. The soil takes in water slowly, but available water capacity is moderate or high. If cultivated, the soil loses its tilth in areas where tillage operations are not properly timed. This soil blows easily if tilth is poor. Runoff is slow.

Many areas are cultivated. This soil is suited to most crops commonly grown in the county. Maintaining tilth and improving water intake rate are concerns of management. Capability unit IIs–1; Clayey range site; windbreak group 4.

Sinai silty clay, 3 to 6 percent slopes (SkB).—This gently sloping soil is at some of the highest levels on uplands. Areas are irregular in shape and are as much as 40 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of Forman and Poinsett soils.

Fertility is high in this Sinai soil. Available water capacity is moderate or high, but the soil takes in water slowly and easily loses its tilth if cultivated. Runoff is medium, and erosion is a hazard.

Most areas are cultivated. This soil is suited to most crops commonly grown in the county. Controlling erosion is the main concern of management. Capability unit IIIe–3; Clayey range site; windbreak group 4.

Sinai silty clay, 6 to 9 percent slopes (SkC).—This sloping soil has a profile similar to that described as representative for the series, but the surface layer and subsoil are thinner and in many areas they are mixed by plowing. Slopes are mostly long and uniform. In eroded spots the soil is calcareous at or near the surface. Included in mapping were areas of Forman and Poinsett soils.

This soil takes in water slowly and loses its tilth easily if cultivated. Runoff is medium, and erosion is a hazard.

Most areas are cultivated. Controlling erosion is the main concern of management. Capability unit IVe–7; Clayey range site; windbreak group 4.

Sioux Series

The Sioux series consists of rolling to steep, excessively drained, loamy soils that formed in glacial outwash material. These soils are very shallow over stratified sand and gravel. They are on uplands.

In a representative profile (fig. 21) the surface layer is dark-gray loam about 5 inches thick. Below this is a transitional layer of calcareous, grayish-brown gravelly loam about 3 inches thick. The underlying material is calcareous, light brownish-gray sand and gravel.

Fertility is low in Sioux soils. Available water capacity is low, and permeability is rapid.

Almost all areas are in native grass and are used for grazing. These soils are not suited to cultivation.

Representative profile of Sioux loam in an area of Sioux-Arvilla loams, 15 to 40 percent slopes, 2,375 feet south and 1,200 feet west of the northeast corner of sec. 33, T. 126 N., R. 53 W.:

A1—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.

AC—5 to 8 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak,

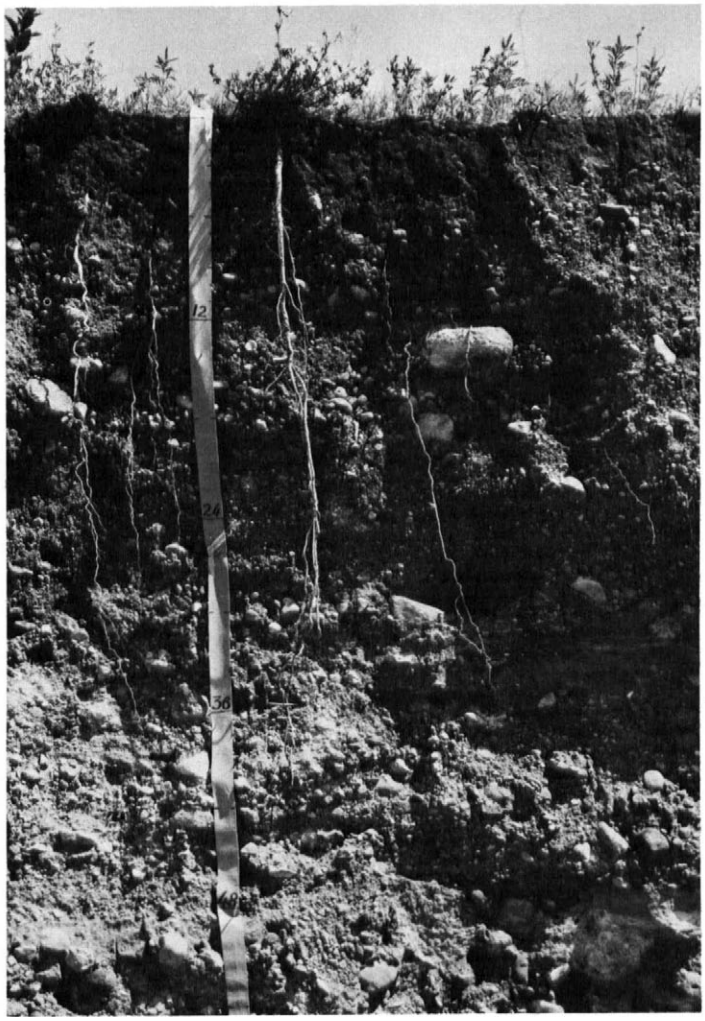

Figure 21.—Sand and gravel are at a depth of about 8 inches in a profile of Sioux loam. Alfalfa roots extend into the sand and gravel.

coarse, granular structure; soft, friable; strong effervescence; moderately alkaline; clear, smooth boundary.

IIC—8 to 60 inches, light brownish-gray (10YR 6/2) and pale-brown (10YR 6/3) sand and gravel, brown (10YR 5/3) and dark yellowish brown (10YR 4/4) moist; single grained; loose; undersides of pebbles coated with segregated lime in the upper part; moderately alkaline.

The A horizon is loam, gravelly loam, sandy loam, or gravelly sandy loam. Depth to sand and gravel ranges from 7 to 14 inches. Lime is commonly at a depth of 3 to 8 inches. In places the soil is stony.

Sioux soils are mapped with Arvilla soils and are near Buse and Renshaw soils. They are shallower over sand and gravel than Arvilla and Renshaw soils. They differ from Buse soils in having a C horizon of sand and gravel.

Sioux-Arvilla loams, 15 to 40 percent slopes (SmE).—Sioux soils make up 75 percent of this complex, Arvilla soils 20 percent, and other soils 5 percent. Areas of these hilly to steep soils are mostly long and narrow and less than 40 acres in size. They are on gravelly ridges. Sioux soils are on the higher parts of the landscape, and Arvilla soils are on the lower parts of side slopes. Arvilla soils have a profile similar to the one described as representative for the Arvilla series, except that the surface layer is thicker in some areas.

Included with these soils in mapping were areas of Renshaw soils on the tops and sides of some of the less steep ridges.

These Sioux and Arvilla soils are droughty and are too steep to be cultivated. Runoff is slow or medium.

All areas are in native grass and are used for grazing. Capability unit VIIs–4; Sioux soils are in Very Shallow range site; Arvilla soils are in Shallow to Gravel range site; both soils are in windbreak group 10.

Stirum Series

The Stirum series consists of deep, nearly level, poorly drained, calcareous, loamy soils that formed in sandy material of glacial-lacustrine origin. These soils have a claypan subsoil. They are on uplands.

In a representative profile the surface layer is dark-gray and gray fine sandy loam about 8 inches thick. The subsoil is gray and dark-gray fine sandy loam about 11 inches thick. The upper part is hard when dry and firm when moist. The lower part has pale-brown mottles. The underlying material, to a depth of 32 inches, is light brownish-gray fine sandy loam mottled with strong brown. Below this is light-gray loamy fine sand mottled with strong brown.

Fertility is low in Stirum soils because of their strong alkalinity and high lime content. Available water capacity is low or moderate. Permeability is moderately slow in the subsoil and moderately rapid below a depth of about 32 inches. The water table is at a depth of less than 3 feet during much of the growing season.

Most areas are in native grass and are used for hay or pasture. If adequately drained, these soils are suited to cultivation.

Representative profile of Stirum fine sandy loam in a cultivated area of Stirum-Ulen fine sandy loams, 1,250 feet east and 285 feet north of the southwest corner of sec. 19, T. 128 N., R. 58 W.:

A11—0 to 5 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, very fine and fine, granular structure; slightly hard, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.

A12—5 to 8 inches, gray (10YR 5/1) and dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, very fine and fine, granular structure; slightly hard, very friable; strong effervescence; moderately alkaline.

B2t—8 to 15 inches, gray (10YR 5/1) and dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, very coarse, columnar structure parting to weak, medium and coarse, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; thin patchy clay films; gray (10YR 6/1) coats on ped surfaces; strong effervescence; strongly alkaline; gradual, smooth boundary.

B3g—15 to 19 inches, gray (5YR 6/1) fine sandy loam, dark gray (5Y 4/1) moist; few, fine, distinct mottles of pale brown (10YR 6/3) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky; strong effervescence; strongly alkaline; gradual, wavy boundary.

C1g—19 to 32 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/6) moist; few fine, distinct mottles of strong brown (7.5YR 5/6) moist; massive; slightly hard, friable, slightly

sticky; strong effervescence; strongly alkaline; clear, smooth boundary.

C2g—32 to 60 inches, light-gray (2.5Y 7/2) loamy fine sand, grayish brown (2.5Y 5/2) moist; common, medium, prominent mottles of strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable; slightly sticky; strong effervescence; strongly alkaline.

The A horizon, when moist, is black or very dark gray. It is fine sandy loam or loam. A thin gray A2 horizon is present in places.

The B2t horizon is fine sandy loam or loam. It has weak columnar structure or weak or moderate prismatic structure. Colors of the A and B horizons are in hue of 10YR, 2.5Y, or 10YR. Mottles in the B3 and C horizons range from faint through prominent. The solum ranges from 16 to more than 30 inches in thickness.

Stirum soils are similar to Larson soils and are mapped with Ulen soils. They contain more sand and less clay than Larson soils and are more poorly drained. Stirum soils are more poorly drained than Ulen soils and are less sandy and contain more sodium than these soils.

Stirum-Ulen fine sandy loams (0 to 2 percent slopes) (Su).—Stirum soils make up about 70 percent of this complex and Ulen soils 30 percent. These soils are nearly level. They are closely intermingled with Stirum soils in low, flat areas and with Ulen soils on slight rises. The Stirum soil that has the profile described as representative for the series is in this complex. In an area northeast of Amherst, however, the subsoil in the Stirum soil contains more clay than that in the representative profile. Northeast of Amherst the underlying material of both soils commonly contains silty material at depths of more than 40 inches.

Included with these soils in mapping were areas of Arveson and Embden soils. Arveson soils are in some of the low areas, and Embden soils are on some of the rises. Also included were small spots of saline soils in some areas.

The water table is at a depth of less than 3 feet in Stirum soils. The subsoil is strongly alkaline in these soils, and tilth is poor in cultivated areas. The content of lime is high in both the Stirum and Ulen soils, and fertility is low or medium.

Many areas have been cultivated, but they are now in tame or native grasses. Flax, barley, rye, and alfalfa are the main crops in cultivated areas. Wetness is the main concern of management, but controlling soil blowing and improving fertility and tilth are also important. Capability unit IVw–2; Stirum soils are in Subirrigated range site and windbreak group 9; Ulen soils are in Sandy range site and windbreak group 2.

Swenoda Series

The Swenoda series consists of deep, nearly level to gently undulating, moderately well drained, loamy soils that formed in eolian sandy material over silty lacustrine material. These soils are on uplands.

In a representative profile the surface layer is dark-gray fine sandy loam about 15 inches thick. The subsoil is dark grayish-brown and grayish-brown fine sandy loam about 14 inches thick. It is soft when dry and friable when moist. The underlying material is calcareous, pale-yellow silt loam.

Fertility is medium in Swenoda soils. Available water capacity is high. Permeability is moderately rapid in the surface layer and subsoil and moderate in the underlying material. If cultivated, these soils are susceptible to blowing.

Most areas are cultivated. A few are in native grass and are used for pasture or hay.

Representative profile of Swenoda fine sandy loam, 0 to 2 percent slopes, 330 feet west and 100 feet north of the southwest corner of sec. 33, T. 128 N., R. 58 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—8 to 15 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; very weak, coarse, subangular blocky structure parting to weak, fine and medium, granular structure; soft, very friable; neutral; gradual, smooth boundary.

B21—15 to 22 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, medium, prismatic structure parting to weak, coarse and very coarse, subangular blocky structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

B22—22 to 29 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; common, fine, distinct mottles of reddish brown (5YR 5/4) moist; weak, medium, prismatic structure parting to weak, coarse and very coarse, subangular blocky structure; soft, very friable; mildly alkaline; abrupt, wavy boundary.

IIClca—29 to 36 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; common, fine, distinct mottles of gray (5Y 5/1) and reddish brown (5Y 5/4) moist; massive; slightly hard, friable; slightly sticky, and slightly plastic; strong effervescence; moderately alkaline.

IIC2—36 to 60 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; common, fine, distinct mottles of gray (5Y 5/1) and reddish brown (5YR 5/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

The A horizon is dark gray or very dark gray. It is commonly fine sandy loam or sandy loam but ranges from loamy fine sand to loam. The A horizon ranges from 12 to 18 inches in thickness.

The B horizon ranges from dark gray to light brownish gray in hue of 10YR or 2.5Y. It is fine sandy loam or sandy loam.

The IIC horizon is silt loam or silty clay loam. The solum ranges from 22 to 40 inches in thickness.

Swenoda soils are near Arveson, Embden, Hecla, and Ulen soils. They are better drained than Arveson and Ulen soils. Swenoda soils differ from Embden soils in having a silty C horizon at depths of less than 40 inches. They are less sandy than Hecla and Ulen soils.

Swenoda fine sandy loam, 0 to 2 percent slopes (SwA).—This nearly level soil has the profile described as representative for the series. Areas are irregular in shape. Included in mapping were small areas of Embden soils.

This Swenoda soil takes in water readily, and available water capacity is high. Runoff is slow. Soil blows easily in cultivated areas.

Most areas are cultivated. Small grains, corn, and alfalfa are the main crops. Controlling soil blowing is the main concern of management. Capability unit IIIe–7; Sandy range site; windbreak group 1.

Swenoda fine sandy loam, 2 to 6 percent slopes (SwB).—This soil is gently undulating. It has a profile similar to the one described as representative for the series but in places is not so deep to silty material. Areas are irregular in shape.

Included with this soil in mapping were Embden soils

in areas where the silty underlying material is at a depth of more than 40 inches.

This Swenoda soil takes in water readily, but soil blowing and erosion are hazards.

Most areas are cultivated. Small grains, corn, and alfalfa are the main crops. Controlling soil blowing and controlling erosion are the main concerns of management. Capability unit IIIe-8; Sandy range site; windbreak group 1.

Swenoda-Larson complex, 0 to 2 percent slopes (SxA).—Swenoda soils make up about 70 percent of this complex (fig. 22) and Larson soils 30 percent. Larson soils are in very slight depressions. Included in mapping were a few small areas of Ulen soils.

The Swenoda soils take in water readily, but permeability is slow in the claypan subsoil of the Larson soils. The Larson soils are slow to dry out, and if cultivated when wet, they easily lose their tilth. Soil blowing is a hazard on these soils.

Most areas are cultivated. Corn, small grains, and alfalfa are the main crops. Controlling soil blowing is the main concern of management, but maintaining tilth and improving water-intake rates in the Larson soil are also important. Capability unit IIIe-7; Swenoda soils are in Sandy range site and windbreak group 1; Larson soils are in Claypan range site and windbreak group 9.

Tonka Series

The Tonka series consists of deep, level, poorly drained, silty soils. They formed in alluvium that washed from adjacent soils. These soils are in depressions on uplands.

In a representative profile the surface layer is dark-gray silt loam about 12 inches thick. Below this is a subsurface layer of gray silt loam about 6 inches thick. The subsoil is gray silty clay loam and silty clay about 22 inches thick. It is hard when dry and firm when moist. The underlying material is light brownish-gray silty clay loam. Mottles of dark brown and reddish brown are in the layers below the surface layer.

Figure 22.—**Cutting silage in an area of Swenoda-Larson complex, 0 to 2 percent slopes.**

Fertility is medium or high in Tonka soils. Available water capacity is high. Permeability is slow in the subsoil and moderately slow in the underlying material. These soils are subject to flooding. The water table is at a depth of less than 4 feet during part of the growing season.

Many areas are cultivated. If adequately drained, the soil is suited to most crops commonly grown in the county. Areas in native grass are used for hay or pasture.

Representative profile of Tonka silt loam in an area of Bearden-Tonka silt loams, 0 to 3 percent slopes, 450 feet north and 120 feet west of the southeast corner of sec. 1, T. 128 N., R. 58 W.:

A1—0 to 12 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky, slightly plastic; slightly acid; clear, smooth boundary.

A2—12 to 18 inches, gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) moist; common, fine, distinct mottles of dark brown (7.5YR 4/4) moist; moderate, very fine and fine, platy structure; slightly hard, friable, slightly sticky, slightly plastic; slightly acid; clear, smooth boundary.

B21t—18 to 23 inches, gray (10YR 6/1) silty clay loam, very dark gray (10YR 3/1) moist; common, fine, faint mottles of dark brown (7.5YR 4/4) moist; weak, coarse and medium, prismatic structure parting to moderate, fine, blocky structure; slightly hard, firm, slightly plastic; bleached sand grains on prism tops and vertical faces of peds; neutral; clear, smooth boundary.

B22t—23 to 40 inches, gray (10YR 6/1) silty clay, very dark gray (10YR 3/1) moist; common, fine, faint mottles of dark brown (7.5YR 4/4) moist; moderate, coarse, prismatic structure parting to moderate, medium and fine, blocky structure; very hard, firm, sticky, plastic; neutral; clear, irregular boundary.

C—40 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; many, fine, prominent mottles of reddish brown (5YR 4/4) moist; massive; slightly hard, firm, sticky, plastic; common tongues of B2 material, 8 to 15 millimeters thick; few pressure faces; mildly alkaline.

The A1 horizon, when moist, is black or very dark gray. It is silt loam or silty clay loam and ranges from 6 to 18 inches in thickness. The A2 horizon, when moist, ranges from very dark gray to gray. Mottles are few or common and are dark brown or yellowish brown. The A2 horizon is silt loam or silty clay loam and ranges from 4 to 16 inches in thickness.

The B2t horizon is silty clay, clay, or silty clay loam. It has weak through strong prominent structure that parts to moderate or strong blocky structure. The solum ranges from 25 to 60 inches in thickness. Depth to lime ranges from 25 to more than 60 inches.

Tonka soils are similar to Aberdeen soils and, like Parnell soils, are in depressions. They are more poorly drained and contain less sodium and other salts than Aberdeen soils. Tonka soils have a more distinct A2 horizon than Parnell soils.

Tonka silt loam (0 to 1 percent slopes) (To).—This level soil is in closed depressions. Areas are circular in shape and are mostly less than 10 acres in size.

Included with this soil in mapping were areas of Bearden and Vallers soils on the outer edges of depressions.

Bearden soils are in the western part of the county, and Vallers soils are in the central and eastern parts.

Fertility is medium or high in this Tonka soil. The soil takes in water slowly, and water ponds on the surface. Wetness delays farming operations some years.

Many areas are cultivated. If adequately drained, this soil is suited to most crops commonly grown in the county. Other areas are used for hay or pasture. Wetness is the main concern of management. Capability unit IIw–1, drained, IVw–1, undrained; Closed Depression range site; windbreak group 10.

Ulen Series

The Ulen series consists of deep, nearly level, moderately well drained or somewhat poorly drained, calcareous, loamy soils that formed in sandy glacial-lacustrine material. In places the sandy material has been reworked and redeposited by wind. These soils are on uplands.

In a representative profile the surface layer is dark-gray fine sandy loam about 10 inches thick. Below this is a transitional layer of gray fine sandy loam about 7 inches thick. The underlying material is light brownish-gray fine sandy loam to a depth of 24 inches and light-gray and light olive-gray loamy fine sand below.

Fertility is medium or low in Ulen soils. Available water capacity is low, and permeability is rapid. The water table fluctuates between depths of 3 and 10 feet. Soil blowing is a hazard.

Most areas are cultivated. A few areas are in native grass and are used for hay or pasture.

Representative profile of Ulen fine sandy loam, 1,550 feet west and 100 feet south of the northeast corner of sec. 25, T. 128 N., R. 59 W.:

Ap—0 to 10 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; moderate, fine, granular structure; soft, very friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

ACca—10 to 17 inches, gray (10YR 6/1) fine sandy loam, dark gray (10YR 4/1) moist; weak, coarse and medium, subangular blocky structure; slightly hard, very friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—17 to 24 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2ca—24 to 38 inches, light-gray (2.5Y 7/2) loamy fine sand, grayish-brown (2.5Y 5/2) moist; common, medium, faint mottles of reddish yellow (7.5YR 6/6) moist; massive; soft, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.

C3g—38 to 54 inches, light-gray (5Y 7/2) loamy fine sand, light olive gray (5Y 6/2) moist; common, medium, distinct mottles of reddish brown (5YR 4/4) and reddish yellow (5YR 6/6) moist; massive; soft, very friable; slight effervescence; mildly alkaline; clear, smooth boundary.

C4g—54 to 60 inches, light olive-gray (5Y 6/2) loamy fine sand, olive (5Y 5/3) moist; many, coarse, prominent mottles of reddish brown (5YR 4/4) and dark reddish brown (5YR 3/4) moist; massive; soft, very friable; slight effervescence; mildly alkaline.

The A horizon is black or very dark gray when moist. Texture is fine sandy loam or loam. This horizon ranges from 8 to 16 inches in thickness. The ACca horizon is gray or light brownish gray in hue of 10YR or 2.5Y.

The C horizon commonly averages loamy fine sand, but it is fine sand in places. Nests of salts are at a depth of more than 24 inches in places.

Ulen soils are near Arveson, Bearden, Hamar, and Hecla soils and are mapped with Stirum soils. They contain more sand and have mottled colors at greater depths than the more poorly drained Arveson soils. Ulen soils are more sandy and less calcareous than Bearden soils. They are more calcareous and have mottled colors at greater depths than the more poorly drained Hamar soils. Ulen soils have a thinner A horizon and are more calcareous than Hecla soils. They are more sandy and lack the sodium-affected B horizon of the Stirum soils.

Ulen fine sandy loam (0 to 2 percent slopes) (Uf).—This soil is nearly level. Areas are irregular in shape and are mostly less than 60 acres in size. This soil has the profile described as representative for the series. In a few areas the underlying material below a depth of 40 inches is silty or clayey. Also, the surface layer is thinner in spots where soil blowing has removed part of it.

Included with this soil in mapping were areas of Arveson, Hamar, and Hecla soils. Arveson and Hamar soils are in slight depressions. Slopes of Hecla soils are gently undulating and convex.

Fertility is medium or low in this Ulen soil. The content of lime is high. Available water capacity is low, but a water table that fluctuates at depths between 3 and 10 feet provides moisture for deep-rooted plants. This soil is subject to blowing if cultivated.

Most areas are cultivated. Small grains, corn, flax, alfalfa, and tame grasses are the main crops. Controlling soil blowing is the main concern of management. Capability unit IIIe–14; Sandy range site; windbreak group 2.

Ulen-Stirum fine sandy loams (0 to 2 percent slopes) (Us).—Ulen soils make up 70 percent of this complex and Stirum soils 30 percent. Ulen soils are on slight rises, and Stirum soils are in low areas.

Included with these soils in mapping were areas of Arveson and Embden soils. Arveson soils are in some of the low areas. Embden soils are on some of the rises.

Fertility is medium to low in these Ulen and Stirum soils. The content of lime is high. The soils are highly susceptible to soil blowing if cultivated. In addition, the Stirum soils are wet during part of the growing season because of a high water table. Stirum soils are strongly alkaline in the subsoil and have poor tilth if cultivated.

Many areas are cultivated. Barley, rye, flax, alfalfa, and tame grasses are the main crops. Controlling soil blowing is the main concern of management, but wetness and improving fertility and tilth are also important. Capability unit IIIe–14; Ulen soils are in Sandy range site and windbreak group 2; Stirum soils are in Subirrigated range site and windbreak group 9.

Vallers Series

The Vallers series consists of deep, level, poorly drained, calcareous loamy soils that formed in glacial till or in local alluvium washed from adjacent soils. These soils are in low areas adjacent to depressions on uplands.

In a representative profile the surface layer is dark-gray loam about 8 inches thick. The underlying material is light-gray clay loam that is noticeably higher in lime content in the upper part. It is mottled in various colors.

Fertility is medium in Vallers soils. Available water

capacity is high, and permeability is moderately slow. A fluctuating water table is at depths ranging from 2 to 5 feet during part of the growing season.

Many areas are cultivated. Other areas are in native grass and are used for hay or pasture.

Representative profile of Vallers loam, 1,800 feet east and 200 feet north of the southwest corner of sec. 24, T. 125 N., R. 54 W.:

A1—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and very fine, granular structure; soft, very friable; slight effervescence; mildly alkaline; abrupt, wavy boundary.

C1ca—8 to 12 inches, light-gray (5Y 7/2) light clay loam, olive gray (5Y 5/2) moist; few, fine, faint mottles of light yellowish brown (2.5Y 6/4) moist; weak, medium, subangular blocky structure parting to weak, fine and medium, granular structure; slightly hard, friable, slightly sticky; violent effervescence; moderately alkaline; clear, smooth boundary.

C2ca—12 to 18 inches, light-gray (5Y 7/2) clay loam, olive gray (5Y 5/2) moist; many, fine and medium, faint mottles of pale yellow (2.5Y 8/4) moist and few, medium, prominent mottles of reddish brown (5YR 5/4) moist; very weak, medium, subangular blocky structure parting to weak, fine and medium, granular structure; slightly hard, friable, sticky; violent effervescence; moderately alkaline; clear, smooth boundary.

C3—18 to 60 inches, light-gray (5Y 7/1) clay loam, gray (5Y 5/1) moist; many, fine and coarse, prominent mottles of yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) moist; massive; slightly hard, firm, sticky; strong effervescence; moderately alkaline.

The A horizon, when moist, is black or very dark gray. It is loam or light clay loam. This horizon ranges from 6 to 12 inches in thickness. An AC horizon is present in places.

The C horizon has colors in hue of 2.5Y or 5Y. It is loam, clay loam, or silty clay loam. Mottles begin at depths of less than 20 inches and are few through many, fine or medium, and faint through prominent. Nests of gypsum crystals are commonly in the C horizon.

Vallers soils are near Hamerly soils and are similar to Bearden soils. They are more poorly drained than Hamerly soils and, unlike the Hamerly soils, have mottles at depths of less than 20 inches. Vallers soils are more poorly drained and less silty than Bearden soils.

Vallers loam (0 to 1 percent slopes) (Va).—This level soil is on flats adjacent to potholes. Mapped areas are mostly less than 10 acres in size.

Included with this soil in mapping were areas of Hamerly, Parnell, and Tonka soils. In a few areas Hamerly soils are intermingled with Vallers soils and make up as much as 50 percent of a given area. Parnell and Tonka soils are in small depressions.

This Vallers soil is wet early in the growing season because of the rise of a high water table. Availability of plant nutrients is affected by the high content of lime in the root zone. Soil blowing is a hazard.

Many areas are cultivated. Flax, barley, rye, sweetclover, and alfalfa are the main crops. Wetness is the main concern of management. Capability unit IIw–3, drained, IVw–1, undrained; Subirrigated range site; windbreak group 2.

Venlo Series

The Venlo series consists of deep, nearly level, very poorly drained, sandy soils that formed in eolian sandy material of glacial-lacustrine origin. These soils are in depressions or old blowout areas on uplands.

In a representative profile the surface layer is dark grayish-brown loamy fine sand about 10 inches thick. The underlying material is light brownish-gray and light olive-gray fine sand. It has many mottles of yellowish brown and bluish gray.

Fertility is medium or low in Venlo soils. Available water capacity is low. Permeability is rapid above the water table, which is at a depth of less than 3 feet and is at or near the surface much of the time.

Almost all areas are in native grass and are used for pasture or hay.

Venlo soils in Marshall County are mapped only with Hecla and Serden soils.

Representative profile of Venlo loamy fine sand in an area of Serden-Venlo complex, 0 to 6 percent slopes, 200 feet east and 200 feet south of the northwest corner of sec. 30, T. 128 N., R. 59 W.:

A1—0 to 10 inches, dark grayish-brown (2.5Y 4/2) loamy fine sand, black (N 2/0) moist; common, fine, distinct mottles of yellowish brown (10YR 5/6) moist; very weak, fine and very fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

C1g—10 to 24 inches, light brownish-gray (2.5Y 6/2) fine sand, dark grayish brown (2.5Y 4/2) moist; many, medium and coarse, prominent mottles of yellowish brown (10YR 5/6) moist; single grained, loose; neutral; clear, smooth boundary.

C2g—24 to 60 inches, light olive-gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; many, medium and coarse, prominent mottles of yellowish brown (10YR 5/6) and bluish gray (5B 5/1) moist; single grained; loose; mildly alkaline.

The A horizon is loamy sand or fine sandy loam and ranges from 6 to 15 inches in thickness.

The C horizon is commonly fine sand but is loamy fine sand or loamy sand in places. Depth to lime ranges from 24 to more than 60 inches. Mottles of yellowish, brownish, and grayish colors are few through many and distinct or prominent throughout the profile. Snail shells are in the soil in places.

Venlo soils are near Arveson and Hamar soils and are mapped with Hecla and Serden soils. They are more poorly drained than Hamar, Hecla, and Serden soils and have mottled colors at or near the surface, which are lacking in those soils. Venlo soils, unlike Arveson soils, are noncalcareous in the upper part.

Waubay Series

The Waubay series consists of deep, nearly level to gently sloping, moderately well drained, loamy soils that formed in silty glacial drift. These soils are in slight depressions, in swales, and on foot slopes on uplands.

In a representative profile the surface layer is very dark gray silty clay loam about 13 inches thick. The subsoil is silty clay loam about 15 inches thick. It is dark gray and dark grayish brown in the upper part and grayish brown in the lower part. Material in the subsoil is slightly hard when dry and friable when moist. The underlying material, to a depth of 42 inches, is calcareous, light-gray silty clay loam. Below this is calcareous, light brownish-gray loam and pale-yellow clay loam. Mottled colors are throughout the underlying material.

Fertility is high in Waubay soils. Available water capacity is high. Permeability is moderate in the upper part of the profile and moderately slow below a depth of about 42 inches. These soils receive runoff water from adjacent sloping soils.

These soils are well suited to all crops commonly grown in the county. Almost all areas are cultivated.

Waubay soils in Marshall County are mapped only with Poinsett soils.

Representative profile of Waubay silty clay loam in an area of Poinsett-Waubay silty clay loams, 0 to 2 percent slopes, 2,340 feet west and 250 feet north of the southeast corner of sec. 12, T. 125 N., R. 57 W.:

Ap—0 to 6 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate, medium and fine, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; abrupt, smooth boundary.

A12—6 to 13 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak, medium subangular blocky structure parting to moderate, medium and fine, granular structure; soft, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B21—13 to 18 inches, dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) silty clay loam, black (10YR 2/1) and very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common fine tongues of material from A1 horizon on faces of peds; mildly alkaline; gradual, smooth boundary.

B22—18 to 28 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; common, fine, faint mottles of dark yellowish brown (10YR 4/4) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; thin, patchy, shiny surfaces on peds; mildly alkaline; abrupt, wavy boundary.

C1ca—28 to 42 inches, light-gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2 moist; common, fine, distinct mottles of strong brown (7.5Y 5/6) moist; massive; slightly hard, friable; common fine to coarse segregations of lime; strong effervescence; moderately alkaline; abrupt, smooth boundary.

IIC2—42 to 45 inches, light brownish-gray (2.5Y 6/2) coarse loam, dark grayish brown (2.5Y 4/2) moist; common, fine, distinct mottles of strong brown (7.5YR 5/6) moist; massive; soft, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

IIC3—45 to 60 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; many, fine to coarse, distinct mottles of gray (5Y 5/1), strong brown (7.5YR 5/6), and yellowish red (5YR 4/8) moist; massive; hard, firm; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark gray in hue of 10YR. It is silt loam or silty clay loam. Thickness ranges from 10 to 18 inches.

The B horizon is heavy silt loam or silty clay loam. The content of clay ranges from 26 to 35 percent. The B horizon ranges from 10 to 20 inches in thickness. Mottling in the lower part of the B and C horizons ranges from faint through prominent. In places the C horizon is silt loam or silty clay loam thinly stratified with very fine sand to a depth of more than 60 inches. In other profiles, layers of sand and gravel or clay loam glacial till are at a depth between 40 and 60 inches. Depth to lime ranges from 20 to 38 inches.

Waubay soils are near Forman and Parnell soils and are mapped with Poinsett soils. They have a thicker A horizon than Forman and Poinsett soils. Waubay soils are better drained and contain less clay in the B horizon than Parnell soils.

Wet Alluvial Land

Wet alluvial land (Wa) consists of mixed soils and soil material along sluggish drainageways that connect potholes and areas of Marsh. The areas are low, long, and narrow and are mostly less than 20 acres in size. Slope is 0 to 1 percent. The soil material ranges from silt loam to silty clay in texture. It is commonly stratified.

Included with this land type in mapping were areas that have many small potholes. In some of the potholes are calcareous clayey soils that, in places, are covered with 8 to 10 inches of muck. The land type Marsh is in others.

This land type has a high water table and is flooded by runoff water from adjacent sloping soils. It is too wet to be cultivated.

This land type is better suited to pasture, hay, and wildlife habitat than to other uses. Capability unit Vw–4; Wet Land range site; windbreak group 10.

Zell Series

The Zell series consists of deep, gently undulating to undulating, well-drained, calcareous, silty soils that formed in silty, glacial-lacustrine material. These soils are on uplands.

In a representative profile the surface layer is dark-gray silt loam about 6 inches thick. Below this is a transitional layer of grayish-brown and light-gray silt loam about 5 inches thick. The underlying material is light-gray and light brownish-gray silt loam.

Fertility is low or medium in Zell soils. Available water capacity is moderate or high. Permeability is moderate.

Many areas are cultivated. Others are in native grass and are used for grazing.

Zell soils in Marshall County are mapped only with Great Bend soils.

Representative profile of Zell silt loam in a cultivated area of Great Bend-Zell silt loams, 6 to 9 percent slopes, 2,400 feet west and 414 feet south of the northeast corner of sec. 32, T. 125 N., R. 59 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine, granular structure; soft, very friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

AC—6 to 11 inches, grayish-brown (2.5Y 5/2) and light-gray (2.5Y 7/2) silt loam, dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) moist; weak, coarse and medium, subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—11 to 19 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; few, fine, distinct mottles of brownish yellow (10YR 6/6) and gray (5Y 5/1) moist; weak, coarse, subangular blocky structure; slightly hard, friable; few fine spots and striations of segregated lime; violent effervescence; moderatey alkaline; clear, wavy boundary.

C2ca—19 to 30 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; common, fine, distinct mottles of brownish yellow (10YR 6/6) moist and few, fine, distinct mottles of gray (5Y 5/1) moist; laminated; slightly hard, friable; violent effervescence; slightly alkaline; clear, wavy boundary.

C3—30 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon is dark gray or dark grayish brown and ranges from 4 to 8 inches in thickness. The combined thick-

ness of the A and AC horizons ranges from 8 to 16 inches. In cultivated areas the A horizon is lighter in color because of mixing with the AC or C horizon by plowing. In places in areas of native grass the A horizon is noncalcareous.

The C horizon ranges from light brownish gray to white or pale yellow in hue of 2.5Y. It is commonly silt loam, but includes loam, very fine sandy loam, and silt. It is distinctly laminated. Segregations of lime in the Cca horizon are few or common and fine or medium. Mottles in the C horizon are inherited from the parent material.

Zell soils are similar to Buse soils and are mapped with Great Bend soils. They are less clayey and are more silty than Buse soils. Zell soils, unlike Great Bend soils, lack a B horizon. Also, they are less clayey and are more calcareous than Great Bend soils.

Use and Management of the Soils

In this section use and management of soils in Marshall County are described for crops, tame pasture, farmstead and field windbreaks, wildlife habitat, and engineering projects.

General Management of Cropland [3]

About 66 percent of the acreage of Marshall County is cropland. Spring wheat, flax, corn, oats, barley, and alfalfa are the main crops. Wheat and flax are cash crops, the other crops being grown mainly for feeding livestock.

The main concerns in managing soils in the county for crops are conserving moisture, controlling erosion and soil blowing, and maintaining or improving tilth, content of organic matter, and fertility. Removing stones, reducing salinity, and improving drainage are also concerns of management for some soils.

Moisture is a limiting factor to crop production in Marshall County in some years. In dryfarmed areas conserving moisture means reducing evaporation, limiting runoff, increasing infiltration, and controlling weeds. Among the good management practices are stubble mulching, returning crop residue to the soil, contour stripcropping (fig. 23) and other contour farming practices, terracing, keeping tillage to a minimum (fig. 24), chiseling, and planting field windbreaks. Summer fallow helps to control weeds and to store moisture in soils. These practices also help to control erosion.

Other practices that help to control erosion are growing cover crops, including close-sown crops in the cropping system, using buffer strips, constructing diversions, and keeping waterways in grass.

Wind stripcropping, growing cover crops, stubble mulching, crop residue management, and planting field windbreaks (fig. 25) are practices that help to control soil blowing. Emergency tillage helps to reduce soil blowing until more effective measures are used.

Maintaining or improving tilth is an important need of management on many of the wet soils and on soils that have a high content of clay. The Aberdeen, Peever, and Sinai soils are examples. Crop-residue management and timely tillage that is kept to a minimum help to maintain soil tilth. Alternating the depth of tillage helps

Figure 23.—Contour stripcropping on an area of Forman-Aastad loams, 2 to 6 percent slopes.

to prevent the formation of tillage pans in such soils as Forman, Kranzburg, and Poinsett. Chiseling and including legumes in the cropping system help to increase water intake in clayey soils, such as those in the Sinai series.

Figure 24.—Corn on an area of Beotia silt loam, 0 to 2 percent slopes, where minimum tillage has been practiced.

[3] By WALTER N. PARMETER, conservation agronomist, Soil Conservation Service.

Figure 25.—**Field windbreak and a good stand of alfalfa help to control soil blowing on Embden fine sandy loam, 2 to 6 percent slopes.**

Most of the soils in Marshall County have a moderate or high content of organic matter. Crop-residue management, use of green-manure crops and animal manure, and use of legumes and grasses in the cropping system are among the measures that help to maintain the content of organic matter.

Most of the soils in the county are medium or high in fertility. Measures that help to maintain the content of organic matter also help to maintain fertility. Many of the soils, however, need applications of chemical fertilizer to obtain desired levels of production. The availability of plant nutrients is affected by the high level of lime and salt in some soils. Nitrogen deficiencies are apt to be evident in years when the rainfall is above average. The kind and amount of fertilizer needed for a specific crop on a given soil can be determined by soil tests. Information about the use of fertilizer can be obtained from local offices of the Soil Conservation Service and from the county agricultural extension agent.

Capability Grouping

Capability grouping of soils shows, in a general way, their suitability for most kinds of farming. It is a practical classification based on the limitations of the soils, the risk of damage when they are used for the ordinary field crops or sown pastures, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitations, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils, and without consideration of possible major reclamation. A complete discussion of the capability classification is given in Agriculture Handbook 210, Land Capability Classification (*6*).

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, forest trees, or engineering.

In the capability system, the kinds of soils are grouped at three levels: capability class, subclass, and unit. These groupings are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in Marshall County)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife food and cover.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife food and cover, water supply, or to esthetic purposes.

Capability Subclasses are soils groups within one class; they are designated by adding a small letter *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation; *s* shows that the soil is limited mainly because it is droughty, stony, or has a shallow root zone; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by Capability Units

In the following pages, each of the capability units in Marshall County is described, and suggestions for the use and management of each capability unit are given. The capability units within a capability subclass are not numbered consecutively, because not all of the units in the statewide system are used.

The names of the soil series represented are mentioned in the description of each unit, but this does not mean that all the soils in a given series are in that unit. Also, when a soil is a member of a mapping unit complex, its capability unit may differ from that when the soil is mapped alone. This is because a complex is treated as a whole in describing management for cropland. To find the capability classification of a given soil in Marshall County, refer to the "Guide to Mapping Units."

CAPABILITY UNIT IIe–1

This unit consists of deep, well-drained, gently sloping soils of the Great Bend, Kranzburg, Poinsett, and Zell series; and moderately deep, well-drained, gently sloping soils of the Edgeley series. Also in this unit are deep, moderately well drained, gently sloping soils of the Aberdeen and Waubay series. These soils have a surface layer of loam, silt loam, or silty clay loam. The subsoil is silt loam, silty clay loam, or clay loam, except for the Aberdeen soil, which has a subsoil of silty clay. The Zell soils are mapped with the Great Bend soils, the Aberdeen soils with the Kranzburg soils, and the Waubay soils with the Poinsett soils.

Fertility is medium or high in Edgeley, Great Bend, Kranzburg, and Poinsett soils, and these soils are easy to work. Available water capacity is high in all except Edgeley soils, where it is moderate. Permeability is mainly moderate, and runoff is slow or medium. Controlling erosion is the main concern of management.

During wet years planting is delayed on Aberdeen and Waubay soils. In addition, Aberdeen soils have poor tilth and slow permeability in the compact, clayey subsoil. Improving tilth and water intake are the management needs on the Aberdeen soil.

Fertility is low or medium in Zell soils. These soils are mapped in a complex with Great Bend soils, and they are calcareous at or near the surface. Improving fertility and organic-matter content and controlling erosion and soil blowing are management needs on Zell soils.

Most areas of the soils in this unit are cultivated. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Stubble mulching or crop-residue management in combination with contour farming are practices that help to control erosion. Some areas that have longer slopes need terraces to hold soil losses to acceptable levels. Use of legumes, grasses, and cover crops in the cropping system also helps to meet management needs.

CAPABILITY UNIT IIe–2

This unit consists of deep, well drained and moderately well drained, gently undulating and gently sloping soils of the Aastad, Forman, and Poinsett series. These soils have a surface layer of loam or silt loam and a subsoil of clay loam or silty clay loam.

Fertility is medium or high in these soils. Tilth is good. Available water capacity is high, and permeability is moderate in the subsoil. Runoff is medium. Controlling erosion is the main concern of management. During wet years planting of crops is delayed in places on the Aastad soil.

Most areas of the soils in this unit are cultivated. The soils are well suited to all crops commonly grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Slopes in most areas are short and irregular so that mechanical practices, such as contour farming and use of terraces, are difficult to apply. Stubble mulching or crop residue management, use of legumes and grasses in the cropping system, and use of cover crops are practices that help to control erosion.

CAPABILITY UNIT IIe–3

Beotia silt loam, 2 to 6 percent slopes, is the only soil in this unit. It has a surface layer and subsoil of silt loam.

Fertility is high in this soil. Tilth is good. Available water capacity is high, and permeability is moderate. The areas receive extra moisture because of runoff from adjacent, sloping soils. Runoff on the Beotia soil is medium. Controlling erosion is the main concern of management.

Most areas of the soil in this unit are cultivated. The soil is well suited to all crops commonly grown in the county.

Stubble mulching or crop-residue management in combination with contour farming are practices that help to control erosion.

CAPABILITY UNIT IIe–4

This unit consists of deep, moderately well drained or somewhat poorly drained, nearly level, silty and loamy soils of the Bearden and Hamerly series. These soils have a subsoil of silt loam or clay loam and are high in lime content. Also in this unit are well-drained soils of the Beotia and Peever series. The Beotia soils are mapped with the Bearden soils, and the Peever soils are mapped with the Hamerly soils.

Fertility is medium in Bearden and Hamerly soils, but the availability of plant nutrients is reduced by the high content of lime. Also, in some years there are periods of wetness caused by the rise of the water table. Controlling soil blowing is the main concern of management, but maintaining fertility and tilth also are important management needs.

Fertility is high or medium in Beotia and Peever soils, and available water capacity is high or moderate. Peever soils have slow permeability and lose their tilth if cultivated. Conserving moisture is the main management need on Beotia soils. Maintaining or improving tilth and water intake are the main management needs on Peever soils.

Most areas of the soils in this unit are cultivated. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Stubble mulching, crop-residue management, and the use of grasses and legumes in the cropping system are practices that help to control soil blowing, maintain fertility, conserve moisture, and maintain or improve tilth and water intake.

CAPABILITY UNIT IIw–1

This unit consists of drained areas of deep, poorly drained, level, clayey and silty soils of the Dovray and Tonka series. Also in this unit are deep, moderately well drained to somewhat poorly drained, silty soils of the Bearden series. The Bearden soils are mapped with the Tonka soils. Dovray and Tonka soils have a clayey subsoil. The Bearden soil is commonly silt loam throughout and is calcareous.

Fertility is medium or high in Dovray and Tonka soils. Available water capacity is moderate or high. Permeability is slow or very slow, and runoff is very slow or ponded. Drainage has been provided to control wetness from flooding and the rise of a fluctuating water table. Planting and tillage operations are delayed by wetness in some years. Dovray and Tonka soils lose their tilth if cultivated when wet. Providing adequate drainage and maintaining soil tilth are the main concerns of management.

Bearden soils are mapped in a complex with Tonka soils. The content of lime is high in these soils, and they blow easily. Controlling soil blowing is the main concern of management.

The soils in this unit are suited to most of the crops grown in the county. Oats, spring wheat, corn, flax, and alfalfa are the main crops.

Bedding, diversion ditches, and open drains are among the measures that help to control wetness. Crop-residue management, timely tillage, use of animal manure, and use of grasses and legumes in the cropping system are practices that help to maintain tilth and control soil blowing.

CAPABILITY UNIT IIw–2

This unit consists of drained areas of deep, somewhat poorly drained or poorly drained, nearly level and level, silty and clayey soils of the Lamoure and Ludden series. These soils have a subsoil of silty clay loam and clay and are high in lime content.

Fertility is medium or high in these soils, but the availability of plant nutrients is affected by the high content of lime. Available water capacity is moderate or high. Permeability is moderate in the Lamoure soil, but it is very slow in the Ludden soil. Drainage has been provided to control wetness from flooding and from the rise of a fluctuating water table. Ludden soils lose their tilth if tilled when wet.

The soils in this unit are suited to most of the crops grown in the county. Corn, flax, rye, spring wheat, barley, alfalfa, and tame grasses are the main crops.

Bedding and open drains are practices that help to remove excess water. Crop-residue management, use of green-manure crops, and timely tillage help to maintain tilth.

CAPABILITY UNIT IIw–3

This unit consists of drained areas of deep, poorly drained, level soils of the Colvin, Oldham, and Vallers series. These soils have a surface layer of silty clay loam or loam and a subsoil of silty clay loam or clay loam. They are very high in lime content.

Fertility is medium in these soils, but availability of plant nutrients is affected by the very high content of lime. Available water capacity is moderate or high, and permeability is moderately slow or slow. Runoff is very slow, or the surface is ponded. Drainage has been provided to control wetness from flooding and the rise of the water table. Controlling wetness is the main concern of management.

The soils in this unit are suited to most of the crops grown in the county. Flax, rye, barley, alfalfa, and tame grasses are the main crops.

Diversion terraces on adjacent soils help to control wetness. Crop-residue management, timely tillage, and use of grasses and legumes are practices that help to maintain tilth.

CAPABILITY UNIT IIs–1

This unit consists of deep, moderately well drained or well drained, nearly level, silty and clayey soils of the Harmony, Peever, and Sinai series. Also in this unit are moderately well drained or somewhat poorly drained, silty soils of the Aberdeen series. All of these soils have a subsoil of silty clay or heavy clay loam.

Fertility is medium or high in these soils. Available water capacity is moderate or high. Permeability is slow in all these soils except for the Harmony soil, which has moderate permeability. Runoff is slow. All the soils are slow to dry out, and they lose their tilth if cultivated when wet. Maintaining or improving tilth and water intake are the main concerns of management. As tilth deteriorates, these soils also are susceptible to soil blowing.

The soils in this unit are suited to most of the crops grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Stubble mulching, crop-residue management, chiseling or subsoiling, use of green-manure crops, and use of grasses and legumes in the cropping system are some of the practices that help to meet the management needs of these soils. Timeliness of tillage is also important.

CAPABILITY UNIT IIc–2

This unit consists of deep, well-drained, nearly level, loamy and silty soils of the Forman, Great Bend, and Kranzburg series. Also in this unit are deep, well-drained to somewhat poorly drained soils of the Aastad, Aberdeen, and Beotia series. All except Aberdeen soils have a surface layer of loam or silt loam and a subsoil of clay loam or silt loam. Aberdeen soils have a surface layer of silty clay loam and a subsoil of silty clay. The Aastad soils are mapped with the Forman soils, the Beotia soils

with the Great Bend soils, and the Aberdeen soils with the Kranzburg soils.

Fertility is medium or high in these soils. Available water capacity is moderate or high. Runoff is slow. Permeability is moderate in all the soils except Aberdeen, which have slow permeability. Aberdeen soils take in water slowly and, if cultivated, easily lose their tilth. Conserving moisture is the main concern of management for soils in this unit, but maintaining or improving tilth and water intake are needed on the Aberdeen soil.

The soils in this unit are suited to all the crops commonly grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Stubble mulching, crop-residue management, and the use of grasses and legumes in the cropping system are practices that help to conserve moisture.

CAPABILITY UNIT IIc-3

This unit consists of deep, moderately well drained or well drained, nearly level, loamy and silty soils of the Aastad, Beotia, Poinsett, and Waubay series. These soils have a surface layer of loam, silt loam, or silty clay loam and a subsoil of clay loam, silt loam, or silty clay loam.

Fertility is high in these soils. Available water capacity is high. Permeability is mainly moderate, but it is moderately slow in the underlying material of Aastad and Waubay soils. Runoff is slow. Aastad, Beotia, and Waubay soils commonly receive extra moisture in the form of runoff from adjacent soils. For the most part the additional moisture is beneficial, but in some years it delays planting of crops. Also, in some years a shortage of moisture occurs late in the growing season. Conserving moisture is the main concern of management.

The soils in this unit are well suited to all crops commonly grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Crop-residue management and the use of grasses and legumes in the cropping system are practices that help to conserve moisture.

CAPABILITY UNIT IIIe-1

This unit consists of deep, well-drained, sloping soils of the Edgeley, Great Bend, and Zell series. These soils have a surface layer of loam or silt loam and a subsoil of clay loam or silt loam.

Fertility is medium or high in Edgeley and Great Bend soils. Tilth is good. Available water capacity is moderate or high, and permeability is moderate. Runoff is medium. Controlling erosion is the main concern of management.

Fertility is medium or low in Zell soils. Organic-matter content is moderately low or low. Many of the cultivated areas are eroded. Controlling erosion and soil blowing are the main concerns of management, but improving fertility and organic-matter content are also important.

Edgeley and Great Bend soils in this unit are well suited to most of the crops grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Crop-residue management in combination with terracing, limited use of row crops, and extensive use of close-sown crops and grasses and legumes in the cropping system are practices that help to control erosion. Use of animal manure and green-manure crops helps to improve fertility and organic-matter content on Zell soils.

CAPABILITY UNIT IIIe-2

This unit consists of deep, well-drained, undulating soils of the Forman and Poinsett series. Also in this unit are deep, moderately well drained soils of the Aastad series. The Aastad soils are mapped with the Forman soils. All of these soils have a surface layer of loam or silt loam and a subsoil of clay loam or silty clay loam.

Fertility is medium or high in these soils. Tilth is good. Available water capacity is high, and permeability is moderate in the subsoil. Runoff is medium. Spring planting on the Aastad soil is delayed in some years because of wetness. Controlling erosion is the main concern of management.

Many areas of the soils in this unit in the Sisseton Hills are in native grass, but the soils are suited to most of the crops grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops.

Stubble mulching and crop-residue management in combination with terracing are practices that help to control erosion, but slopes in many areas are too short and irregular for mechanical practices, such as terracing and contour farming. Limited use of row crops and extensive use of close-sown crops and grasses and legumes in the cropping system are alternative practices that help to control erosion.

CAPABILITY UNIT IIIe-3

This unit consists of deep, well-drained, gently sloping, loamy and clayey soils of the Peever and Sinai series. These soils have a subsoil of heavy clay loam or silty clay.

Fertility is medium or high in these soils. Available water capacity is moderate or high. Permeability is slow, and runoff is medium. Controlling erosion and maintaining tilth are the main concerns of management.

The soils in this unit are suited to most of the crops grown in the county. Corn, oats, flax, spring wheat, barley, alfalfa, and tame grasses are the main crops.

Crop-residue management in combination with contour farming or terracing are practices that help to control erosion. Use of green-manure crops and the use of grasses and legumes in the cropping system help to maintain or improve tilth and improve water intake. Timely tillage is also important on these soils.

CAPABILITY UNIT IIIe-6

Fordville loam, 2 to 6 percent slopes, is the only soil in this unit. It is underlain by sand and gravel at a depth of about 25 inches.

Fertility is medium in this soil, but the soil is somewhat droughty. Permeability is moderate to a depth of about 25 inches and rapid in the underlying sand and gravel. Runoff is medium. Controlling erosion and soil blowing and conserving moisture are important management needs.

The soil in this unit is better suited to small grains and tame grasses than to deep-rooted crops, such as corn. Oats, flax, rye, spring wheat, barley, and alfalfa are the main crops.

Crop-residue management in combination with contour farming or contour stripcropping and use of grasses and legumes in the cropping system are practices that help to meet management needs.

CAPABILITY UNIT IIIe-7

This unit consists of deep, well drained or moderately well drained, nearly level soils of the Embden, Larson, and Swenoda series. Embden and Swenoda soils have a surface layer and subsoil of fine sandy loam. Larson soils are mapped with Swenoda soils. They have a surface layer of loam and a claypan subsoil of light clay loam.

Fertility is medium in Embden and Swenoda soils. Available water capacity is moderate or high. Permeability is moderately rapid, and runoff is slow. Controlling soil blowing is the main concern of management.

Fertility is low in Larson soils. Permeability is slow in the claypan subsoil. Improving fertility, tilth, and intake of water are concerns of management.

Most areas are cultivated. Corn, oats, rye, spring wheat, barley, and alfalfa are the main crops. Rye commonly is used as a winter cover crop.

Crop-residue management, wind stripcropping, use of close-sown crops, use of green-manure crops, and field windbreaks are among the practices that help to control soil blowing.

CAPABILITY UNIT IIIe-8

This unit consists of deep, well drained or moderately well drained, gently undulating and undulating soils of the Buse, Embden, and Swenoda series. Embden and Swenoda soils have a surface layer and subsoil of fine sandy loam. Buse soils are mapped with Embden soils. They have a surface layer of loam over underlying layers of light clay loam.

Fertility is medium in Embden and Swenoda soils. Available water capacity is moderate or high, and permeability is moderately rapid. Runoff is slow, but erosion is a hazard. Controlling soil blowing and erosion are the main concerns of management.

Fertility is low or medium in Buse soils. Cultivated areas commonly are moderately eroded. Controlling erosion and improving fertility are management needs on Buse soil.

Many areas are cultivated. Corn, oats, rye, spring wheat, barley, alfalfa, and tame grasses are the main crops. Rye commonly is used as a winter cover crop.

Stubble mulching and crop-residue management in combination with contour stripcropping are practices that help to control soil blowing and erosion. Field windbreaks help to control soil blowing. Use of grasses and legumes in the cropping system and use of green-manure crops and animal manure help to improve fertility and organic-matter content.

CAPABILITY UNIT IIIe-14

This unit consists of deep, moderately well drained to poorly drained, nearly level fine sandy loams of the Stirum and Ulen series. These soils are high in lime content. The Stirum soil has a claypan subsoil that is strongly alkaline.

Fertility is medium or low in all these soils. Available water capacity is low or moderate. Permeability is rapid in the Ulen soil, but it is moderately slow in the Stirum soil. Controlling soil blowing is the main concern of management, but controlling wetness is also a concern on the poorly drained Stirum soil. Improving fertility and tilth in areas of the Stirum soil is an additional important management need.

The Ulen soil in this unit is suited to most of the crops grown in the county. Corn, oats, flax, rye, spring wheat, barley, and alfalfa are the main crops.

Stubble mulching, crop-residue management, wind stripcropping, field windbreaks, winter cover crops, and use of grasses and legumes in the cropping system are among the practices that help to meet the needs of management.

CAPABILITY UNIT IIIw-2

Drained areas of Parnell silty clay loam are in this unit. This deep, poorly drained or very poorly drained, level soil has a surface layer of silty clay loam and a subsoil of silty clay.

Fertility is high in this soil. Available water capacity is moderate or high, and permeability is slow. The surface of this soil is normally ponded, and drainage has been provided to control the ponding and wetness caused by rise of the water table. Controlling wetness and maintaining tilth are the main concerns of management.

The soil in this unit is suited to most of the crops grown in the county. Corn, oats, flax, spring wheat, barley, and alfalfa are the main crops. Late-planted crops, such as millet and sudangrass, are used in wet years.

Controlling runoff on adjacent soils and using open drains are practices that help to control wetness. Crop-residue management and timely tillage help to maintain tilth.

CAPABILITY UNIT IIIw-5

Hamar fine sandy loam is the only soil in this unit. This somewhat poorly drained soil has a surface layer of fine sandy loam over loamy fine sand or fine sand.

Fertility is medium in this soil. Available water capacity is low or moderate. The soil is commonly wet early in the growing season because of the rise of the water table. Controlling wetness is the main concern of management, but controlling soil blowing is also a management need.

The soil in this unit is suited to most of the crops grown in the county. Corn, oats, flax, rye, spring wheat, barley, and alfalfa are the main crops. Late-planted crops, such as millet and sudangrass, are used in wet years.

Drainage installations that control the level of the water table help to control wetness. Among the practices that help to control soil blowing are crop-residue management, wind stripcropping, providing field windbreaks, using winter cover crops, and including close-sown crops, grasses, and legumes in the cropping system.

CAPABILITY UNIT IIIs-1

Only soils of the mapping unit Aberdeen-Exline silty clay loams, 0 to 2 percent slopes, are in this unit. These are deep, moderately well drained or somewhat poorly drained, nearly level soils that have a surface layer of silty clay loam or silt loam and a subsoil of silty clay. The Exline soil has a compact, claypan subsoil.

Available water capacity is moderate or high in Aberdeen soil, but the clayey subsoil of this soil releases mois-

ture slowly to plants. Permeability is slow in the Aberdeen soil, and the soil dries slowly in spring. Maintaining or improving tilth and improving water intake of the Aberdeen soil are the main concerns of management.

Available water capacity is low or moderate in the Exline soil, and permeability is very slow. This soil is normally not suited to cultivation, but in this unit it is managed with the dominant Aberdeen soil, which is suited.

Aberdeen soils in this unit are suited to most of the crops grown in the county. Corn, spring wheat, barley, flax, and alfalfa are the main crops.

Stubble mulching, crop-residue management, use of legumes in the cropping system, chiseling, and timely tillage are practices that help to maintain or improve tilth and intake of water.

CAPABILITY UNIT IIIs-2

This unit consists of well-drained, nearly level, loamy and silty soils of the Estelline and Fordville series. These soils are underlain by sand and gravel at moderate depths.

Fertility is medium in these soils. Available water capacity is moderate or low. Permeability is moderate in the soils and rapid in the underlying sand and gravel. Conserving moisture is the main concern of management.

The soils in this unit can be used for most of the crops grown in the county, but they are better suited to small grains and tame grasses than to deep-rooted crops, such as corn.

Crop-residue management and use of grasses and legumes in the cropping system are practices that help to meet management needs. Limiting the use of row crops helps to conserve moisture.

CAPABILITY UNIT IIIs-4

In this unit are moderately well drained or somewhat poorly drained, nearly level, loamy soils of the Divide series. These soils are high in lime content and are underlain by sand and gravel at moderate depths.

Fertility is medium in these soils, but the availability of plant nutrients is affected by the high content of lime. These soils are wet in spring because of the rising water table, but they are droughty later in the growing season. Conserving moisture and improving fertility are the main concerns of management.

The soils in this unit are better suited to small grains, flax, and alfalfa than to row crops.

Crop-residue management, use of green-manure crops and animal manure, and use of grasses and legumes in the cropping system are practices that help to meet management needs.

CAPABILITY UNIT IVe-1

This unit consists of deep, moderately well drained and well drained, strongly sloping and rolling, loamy and silty soils of the Aastad, Buse, Edgeley, Forman, Poinsett, and Sieche series and deep, well-drained, undulating and sloping, eroded soils of the Forman and Kranzburg series. All of these soils have a surface layer of loam or silt loam and a subsoil of clay loam, silt loam, or silty clay loam.

Fertility is generally medium or high in these soils, but it is low or medium in areas of the Buse soil or in eroded areas. Available water capacity is moderate or high, and permeability is moderate. Runoff is medium, and the hazard of erosion is severe in cultivated areas. Controlling erosion is the main concern of management, but maintaining or improving fertility and conserving moisture also are important management needs.

Most areas of the soils in this unit are in native grass. The soils are suited to most of the crops grown in the county, but they are better suited to close-sown crops and grasses and legumes than to row crops because of the hazard of erosion.

Contour stripcropping and terracing help to control erosion on the longer slopes, but in many areas slopes are too short and irregular for these mechanical practices. In these areas crop residue management, use of close-sown crops, use of winter cover crops, and use of grasses and legumes in the cropping system are alternative practices. Using grass-covered waterways helps to prevent the forming of gullies.

CAPABILITY UNIT IVe-6

Renshaw-Fordville loams, 6 to 9 percent slopes, is the only mapping unit in this capability unit. These loamy soils are underlain by sand and gravel. Renshaw soils are shallow over sand and gravel, but the less extensive Fordville soil is moderately deep over sand and gravel.

Fertility is low or medium in these soils. The soils are droughty. Permeability is rapid in the underlying sand and gravel. Runoff is medium. Controlling erosion and soil blowing, conserving moisture, and improving fertility and organic-matter content are concerns of management.

The soils in this unit are better suited to small grains and tame grasses than to deep-rooted crops, such as corn. Oats, flax, rye, spring wheat, barley, and alfalfa are the main crops.

Crop-residue management in combination with contour stripcropping helps to control erosion and soil blowing and helps to conserve moisture. Use of close-sown crops and grasses and legumes in the cropping system and use of green-manure crops also help to meet management needs. Grass-covered waterways help to prevent the forming of gullies.

CAPABILITY UNIT IVe-7

This unit consists of deep, well-drained, sloping, loamy and clayey soils of the Peever and Sinai series. These soils have a subsoil of heavy clay loam and silty clay.

Fertility is medium or high in these soils. Available water capacity is moderate or high. Permeability is slow, and runoff is medium. Tilth deteriorates if the soils are worked when wet. Controlling erosion and maintaining tilth are the main concerns of management.

These soils are suited to all the crops commonly grown in the county. Corn, flax, spring wheat, barley, alfalfa, and tame grasses are the main crops.

A combination of stubble mulching or crop-residue management, terracing, and use of grasses and legumes in the cropping system are practices that help to meet management needs. Timely tillage helps to maintain tilth.

CAPABILITY UNIT IVe-9

This unit consists of deep, moderately well drained or well drained, nearly level to gently undulating, sandy soils of the Hecla and Maddock series. Also in this unit are deep, poorly drained or somewhat poorly drained, sandy soils of the Hamar series. The Hamar soils are mapped with the Hecla soils.

Fertility is medium or low in Hecla and Maddock soils. Available water capacity is low or moderate. Permeability is rapid, and runoff is slow. These soils blow easily and are droughty. Controlling soil blowing is the main concern of management.

The Hamar soil also blows easily. It has a water table at a depth of less than 3 feet. Controlling wetness and soil blowing are concerns of management.

The soils in this unit are suited to corn, oats, barley, flax, rye, alfalfa, and tame grasses.

Crop-residue management, wind stripcropping, field windbreaks, use of winter cover crops, use of close-sown crops in preference to corn, and use of grasses and legumes in the cropping system are practices that help to control soil blowing. Drainage helps to control wetness in areas of the Hamar soil.

CAPABILITY UNIT IVw-1

This unit consists of deep, somewhat poorly drained or poorly drained, level and nearly level, loamy, silty, and clayey soils of Oldham silty clay loam, saline, and Playmoor silty clay loam and undrained areas of Colvin, Lamoure, Ludden, Oldham, Tonka, and Vallers soils. The Colvin, Lamoure, Oldham, and Playmoor soils have a subsoil of silty clay loam, Ludden and Tonka soils have a subsoil of clay or silty clay, and Vallers soils have a subsoil of clay loam. Oldham silty clay loam, saline, and Playmoor silty clay loam contain salts at shallow depths.

Fertility is medium or high in these soils. Available water capacity is moderate or high. Permeability is moderate in the Lamoure soil; moderately slow in the Colvin, Playmoor, and Vallers soils; slow in the Oldham and Tonka soils; and very slow in the Ludden soil. Runoff is slow or ponded. These soils are subject to wetness from flooding and a high water table. Spring planting and tillage operations are delayed in most years. Wetness is the main concern of management.

The soils in this unit are better suited to late-planted crops, such as flax, millet, and sudangrass, than to other crops. Some areas are better suited to hayland, pasture, or wildlife uses.

Crop-residue management, use of green-manure crops, and timely tillage help to maintain fertility and tilth. If drainage is feasible on areas of Colvin, Lamoure, Ludden, Oldham, Tonka, and Vallers soils, controlling runoff on adjacent slopes and providing drainage structures are practices that help to provide drainage. Feasibility of drainage is determined by onsite inspection. If adequately drained, the Tonka soil is in capability unit IIw-1, Lamoure and Ludden soils are in capability unit IIw-2, and Colvin, Oldham, and Vallers soils are in capability unit IIw-3.

CAPABILITY UNIT IVw-2

This unit consists of deep, poorly drained or somewhat poorly drained, nearly level soils of the Hamar and Stirum series. Also in this unit are deep, moderately well drained or somewhat poorly drained soils of the Ulen series. The Ulen soils are mapped with the Stirum soils. These soils have a surface layer of loamy fine sand or fine sandy loam. The Stirum soil is calcareous and has a claypan subsoil that is strongly alkaline.

Fertility is medium or low in all these soils. Available water capacity is low or moderate. Runoff is slow or very slow. The Hamar and Stirum soils are commonly wet early in the growing season. All of these soils blow easily. Controlling wetness and soil blowing are the main concerns of management, but maintaining or improving tilth of the Stirum soil is also a management concern.

Flax, barley, rye, and alfalfa are the main crops. Millet and sudangrass are late-planted crops that are used in wet years. Some areas are better suited to hay, pasture, or wildlife habitat than to other uses.

Drainage structures help to control wetness. Crop-residue management, wind stripcropping, field windbreaks, use of grasses and legumes in the cropping system, use of green-manure crops, and use of winter cover crops are practices that help to control soil blowing and improve tilth and fertility.

CAPABILITY UNIT IVs-1

Renshaw-Fordville loams, 0 to 3 percent slopes, is the only mapping unit in this capability unit. These loamy soils are underlain by sand and gravel. Renshaw soils are shallow over sand and gravel, and the less extensive Fordville soil is moderately deep over sand and gravel.

Fertility is low or medium in these soils. The soils are droughty. Permeability is rapid in the underlying sand and gravel. Runoff is slow. Conserving moisture, controlling soil blowing, and improving fertility and organic-matter content are concerns of management.

The soils in this unit are better suited to flax, small grains, and tame grasses than to other crops, but corn and alfalfa are grown in some areas.

Crop-residue management, use of grasses and legumes in the cropping system, and use of green-manure crops are practices that help to meet management needs. Wind stripcropping helps to control soil blowing.

CAPABILITY UNIT Vw-1

This unit consists of poorly drained and very poorly drained, nearly level soils of the Arveson and Benoit series. The Arveson soils are deep, and the Benoit soils are moderately deep over sand or sand and gravel. These soils are high in lime content.

Fertility is medium or low in these soils. The water table is at or near the surface during part of the growing season most years.

Soils in this unit are not suitable for cultivation. Some areas are suited to tame grasses. The soils are better suited to hay, pasture, or wildlife habitat than to other uses. Drainage practices are not practical in most areas.

CAPABILITY UNIT Vw-4

In this unit are Parnell silty clay loam and the land type Wet alluvial land. The Parnell soil is deep, poorly drained or very poorly drained, and level. It has a surface layer of silty clay loam and a subsoil of silty clay. Wet alluvial land consists of mixed soils and soil materials of silty to clayey texture.

Parnell silty clay loam in this unit is undrained. Both Parnell silty clay loam and Wet alluvial land have a high water table and are too wet for cultivation or for the introduction of tame grasses that provide more desirable plants for grazing.

The areas of this unit are better suited to hay, pasture, and wildlife habitat than to other uses. More than half of the vegetation is suitable for grazing.

Some areas of Parnell silty clay loam are drained and are in capability unit IIIw–2. Feasibility of drainage is determined by onsite inspection.

CAPABILITY UNIT VIe–1

Forman-Buse loams, 15 to 25 percent slopes, is the only mapping unit in this capability unit. These are deep, well-drained, hilly, loamy soils that have a subsoil and underlying material of clay loam.

Fertility is medium or high in the Forman soil, but it is medium or low in the Buse soil. Available water capacity is high in both soils. Runoff is medium or rapid.

The soils in this unit are too erosive for cultivation. Most of the areas are in native grass and are used for pasture or hay. Maintaining a good cover of grass helps to control erosion.

CAPABILITY UNIT VIe–3

This unit consists mainly of deep, well-drained, rolling to hilly soils of the Buse series. These soils have a surface layer of loam over calcareous clay loam glacial till. Also in this unit are deep, well-drained, loamy soils of the Forman series and excessively drained loamy soils of the Sioux series. The Forman and Sioux soils are mapped with the Buse soils. Sioux soils are very shallow to gravel.

Fertility is low or medium in the Buse soil, and available water capacity is high. Runoff is medium or rapid on the Buse and Forman soils, but it is slow on the Sioux soil. The soils in this unit are too susceptible to erosion to be cultivated. Most areas are in native grass and are used for pasture or hay. Maintaining a good cover of grass helps to control erosion.

CAPABILITY UNIT VIe–5

Renshaw-Fordville loams, 6 to 9 percent slopes, is the only mapping unit in this capability unit. These somewhat excessively drained or well-drained, undulating and sloping, loamy soils are shallow to moderately deep over sand and gravel.

Permeability is rapid in the underlying sand and gravel. The soils in this unit are too droughty and too susceptible to erosion for cultivation. Most areas are in native grass and are used for pasture. Maintaining a good grass cover helps to control erosion.

CAPABILITY UNIT VIe–6

Arvilla-Sioux loams, 9 to 25 percent slopes, is the only mapping unit in this capability unit. These are excessively drained, rolling to hilly, loamy soils that are underlain by sand and gravel. Arvilla soils have a subsoil of coarse sandy loam and are shallow over sand and gravel. Sioux soils are very shallow over sand and gravel.

Fertility is low in these soils. Available water capacity is low. The soils are susceptible to erosion and soil blowing and are droughty. They are not suited to cultivation. Most of the areas are in native grass and are used for pasture. Maintaining a good grass cover helps to control erosion and soil blowing.

CAPABILITY UNIT VIe–7

This unit consists of deep, moderately well drained to excessively drained, nearly level to hilly, sandy soils of the Hecla, Maddock, and Serden series. Also in this unit are deep, very poorly drained, sandy soils of the Venlo series. The Venlo soils are mapped with the Hecla and Serden soils. The soils in this unit are loamy fine sand or fine sand throughout. Soils in cultivated and formerly cultivated areas are eroded as a result of soil blowing.

Fertility is medium or low in these soils. Available water capacity is generally low, but it is low or moderate in the Hecla soil. Permeability is rapid, and runoff is slow or very slow. These soils are highly susceptible to soil blowing. Venlo soils are wet.

The soils in this unit are not suited to cultivation because of the hazard of soil blowing. Also, the Venlo soils are not suited to cultivation because of wetness. Most areas are in native grass and are used for pasture and hay.

Maintaining a good grass cover helps to control soil blowing. Dune stabilization measures help to restore a grass cover in sand blowout spots.

CAPABILITY UNIT VIw–3

This unit consists of the land types Loamy alluvial land and Sandy lake beaches. Loamy alluvial land, in many areas, is subject to flooding from meandering stream channels. Sandy lake beaches is subject to flooding when water levels are high in the adjacent lakes.

These land types of mixed soils and soil material are not suited to cultivation. They are better suited to hay, pasture, or wildlife habitat than to other uses.

CAPABILITY UNIT VIs–1

Exline-Aberdeen silty clay loams, 0 to 2 percent slopes, is the only mapping unit in this capability unit. Exline soils are deep, somewhat poorly drained, and nearly level. They have a thin surface layer of silt loam over a claypan subsoil of dense silty clay. The lower part of the subsoil is high in salts. Aberdeen soils are deep, moderately well drained soils that have a surface layer of silty clay loam and a subsoil of silty clay.

Fertility is low in Exline soils. Available water capacity is low or moderate. Permeability is very slow, and the claypan subsoil releases moisture slowly to plants. Exline soils are not suited to cultivation.

Fertility is medium in Aberdeen soils. Available water capacity is moderate, and permeability is slow. Although they are suited to cultivation, their use is governed by the dominant Exline soil.

Many areas of soils in this unit are cultivated, but they are better suited to hay and pasture.

CAPABILITY UNIT VIIe–1

Sieche loam, 21 to 50 percent slopes, is the only soil in this unit. This deep, well-drained, hilly to very steep soil has a thick surface layer of loam and a subsoil of clay and clay loam.

Fertility is medium or high in this soil. Available water capacity is high.

The soil in this unit is too steep and too susceptible to erosion for cultivation. Most areas are in native trees. These wooded areas have a sparse understory of native grasses. The trees are mainly bur oak, maple, basswood, and green ash. These areas have limited value for grazing, but have a potential for wildlife habitat and recreational development.

Maintaining the vegetative cover is needed to control erosion.

CAPABILITY UNIT VIIe-3

This unit consists of well-drained, steep, loamy soils of the Buse, Forman, and Kloten series. Buse and Forman soils are deep, and they formed in loamy glacial till. Kloten soils are shallow over shale.

Fertility is low or medium in Buse and Kloten soils, but it is medium or high in the Forman soils. Runoff is rapid on soils of this unit, and the hazard of erosion is severe.

The soils in this unit are too steep for cultivation or for hay. All areas are in native grass that is used for grazing. Maintaining a good grass cover helps to control erosion.

CAPABILITY UNIT VIIs-4

Sioux-Arvilla loams, 15 to 40 percent slopes, is the only mapping unit in this capability unit. These excessively drained, hilly to steep soils are very shallow and shallow over sand and gravel.

Fertility and available water capacity are low in these soils. Permeability is rapid in the underlying sand and gravel.

These soils are too steep and too droughty for cultivation. All areas are in native grass that is used for grazing. Maintaining a good vegetative cover helps to control erosion and soil blowing.

CAPABILITY UNIT VIIs-6

This unit consists of stony Buse, Forman, and Sioux soils that are undulating to steep.

Fertility and available water capacity are low through high in these soils.

The soils in this unit are too stony for cultivation. All areas are in native grass and are used for pasture. The soils differ widely in their ability to produce forage for grazing. Maintaining a good vegetative cover helps to control erosion.

CAPABILITY UNIT VIIIw-1

Marsh is the only mapping unit in this capability unit. Areas of this land type are wet and are under water much of the time. Many are covered by small bodies of open water.

Marsh is too wet for most plants and has little value for farming. It is suited to wildlife habitat. The vegetation is rushes, cattail, and sedges.

Estimated Yields

Table 2 lists, for each soil in the county judged suitable for crops, the estimated average yield per acre of principal crops in the county. The estimates are for dryfarmed soils under two levels of management.

The yields shown in columns A were obtained under the kind of management most farmers in the county were practicing in 1967. Under that kind of management, the basic cropping system is 30 percent row crops, 50 percent small grains, and 20 percent grasses and legumes. Most of the grasses and legumes are grown in a long-term cropping system. Grain stubble and other crop residue is plowed under or incorporated in the surface layer. Green-manure crops seldom are grown. Commercial fertilizer is used on most crops, but the kinds and amounts applied are not those recommended by the results of laboratory tests and field trials. Barnyard manure is applied, where it is available, on areas that are convenient. Stubble mulching, contour farming, terracing, and other practices that conserve soil and water are not used.

The yields in columns B can be expected under improved management. This is assumed to be an efficient and economical system of cropping in which, for example, corn is planted in narrow rows in which plant population is optimal, minimum tillage is practiced, and weeds are controlled. Also, a cropping system that maintains soil fertility and tilth is used. Appropriate practices that conserve moisture and control erosion and soil blowing are applied. Clean, high-quality, treated seed of adapted disease-resistant varieties is planted. All crop residue is returned to the soil and is incorporated into the surface layer. Green-manure crops are grown, and barnyard manure is added to increase fertility and add organic matter. The results of laboratory tests and field trials are used as a basis for planning applications of the most economical amounts and kinds of commercial fertilizer. An economical and effective weed-control program is an essential part of these farming operations. Wet potholes are adequately drained for the crops grown.

Yield estimates are based on information furnished by farmers and agricultural specialists familiar with the soils of the county. This information was then compared with farm statistics compiled by the South Dakota Crop and Livestock Reporting Service (*8*).

Management of Tame Pastures [4]

Tame pastures are common in Marshall County, and they supplement the grazing provided by native green pastures. Many of these pastures are grazed too closely during all of or part of a grazing season. Close grazing decreases the stand, which results in increased runoff and greater exposure of the soil to erosion and soil blowing.

Grazing tame pastures in accordance with the amount of forage produced is basic to good pasture management. This practice also helps control erosion and soil blowing. The largest return from grazing is obtained by withholding livestock from a pasture until the grass is at the height recommended for that species.

Good pasture management also includes rotation grazing, clipping to encourage uniform grazing, brush and weed control, development of water facilities (fig. 26), use of fertilizers, and reseeding to adapted grasses for stand improvement and increased production.

[4] By WALTER N. PARMETER, conservation agronomist, Soil Conservation Service.

TABLE 2.—*Estimated average yields per acre of principal dryfarmed crops under two levels of management*

Yields in columns A can be expected under prevailing management; those in columns B can be expected under improved management. Absence of a yield figure indicates that the crop is not commonly grown on the soil. Only soils suitable for crops are listed. Soil complexes are given one yield based on the weighted averages of the composition of soils in the complex]

Soil	Corn ensilage		Corn		Spring wheat		Barley		Flax		Oats		Alfalfa	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Aastad loam, 0 to 2 percent slopes	8	12	42	64	19	28	36	52	11	18	48	68	2. 2	3. 0
Aberdeen-Exline silty clay loams, 0 to 2 percent slopes	4	7	25	35	14	23	20	32	7	12	27	44	1. 3	2. 1
Bearden silt loam	7	11	35	54	15	24	32	45	9	14	43	61	1. 4	2. 5
Bearden-Tonka silt loams, 0 to 3 percent slopes	6	10	33	53	14	23	30	41	9	14	38	55	1. 6	2. 5
Benoit and Divide loams:														
Benoit soil														
Divide soil	3	6	16	28	12	23	19	30	8	15	25	40	1. 4	2. 4
Beotia silt loam, 0 to 2 percent slopes	9	14	47	69	20	29	37	53	11	17	50	70	2. 0	2. 7
Beotia silt loam, 2 to 6 percent slopes	8	13	45	66	19	28	36	52	10	16	49	69	1. 9	2. 5
Beotia-Bearden silt loams, 0 to 3 percent slopes	8	12	43	60	17	26	34	41	10	15	46	55	1. 7	2. 6
Colvin silty clay loam	4	9	22	46	14	24	26	44	8	14	35	59	1. 6	2. 6
Dovray silty clay	6	9	30	45	15	23	26	41	8	14	35	54	1. 6	2. 6
Edgeley loam, 2 to 6 percent slopes	6	8	30	40	14	24	26	38	6	10	34	50	1. 6	2. 1
Edgeley loam, 6 to 9 percent slopes	5	7	25	35	13	22	23	30	5	9	30	40	1. 4	1. 9
Edgeley loam, 9 to 15 percent slopes	4	6	20	30	8	17	15	22	4	7	20	33	1. 4	1. 9
Embden fine sandy loam, 0 to 2 percent slopes	7	10	35	50	14	26	23	34	7	14	30	45	1. 5	2. 0
Embden fine sandy loam, 2 to 6 percent slopes	6	9	32	47	13	23	21	32	7	13	28	42	1. 4	1. 9
Embden-Buse complex, 2 to 9 percent slopes	5	8	28	43	12	21	20	31	6	12	27	41	1. 3	1. 8
Estelline silt loam, 0 to 2 percent slopes	6	8	32	46	16	24	26	38	9	13	35	50	1. 5	2. 0
Fordville loam, 0 to 2 percent slopes	6	8	29	42	14	22	24	35	8	12	32	46	1. 4	1. 9
Fordville loam, 2 to 6 percent slopes	5	8	26	36	12	20	20	31	6	10	27	43	1. 3	1. 8
Forman-Aastad loams, 0 to 2 percent slopes	8	12	40	60	16	26	30	48	9	15	40	65	1. 6	2. 4
Forman-Aastad loams, 2 to 6 percent slopes	8	11	38	58	14	23	28	47	8	14	38	63	1. 6	2. 4
Forman-Aastad loams, 6 to 9 percent slopes	6	9	32	49	12	21	26	41	6	12	34	55	1. 5	2. 3
Forman-Aastad loams, 9 to 15 percent slopes	5	8	23	39	10	18	20	44	4	10	26	45	1. 3	2. 2
Forman-Buse loams, 6 to 9 percent slopes, eroded	4	7	22	40	10	18	22	38	5	11	29	50	1. 2	2. 1
Forman-Poinsett complex, 6 to 9 percent slopes	6	9	30	46	11	20	24	40	5	11	24	48	1. 4	2. 1
Forman-Poinsett complex, 9 to 15 percent slopes	4	7	20	35	9	17	18	36	4	8	24	48	1. 2	2. 1
Great Bend silt loam, 2 to 6 percent slopes	8	11	39	55	16	21	35	48	9	14	47	64	1. 8	2. 3
Great Bend-Beotia silt loams, 0 to 2 percent slopes	9	12	43	60	18	27	37	50	10	15	49	66	2. 0	2. 5
Great Bend-Zell silt loams, 2 to 6 percent slopes	7	10	34	50	14	20	32	45	8	45	42	60	1. 6	2. 1
Great Bend-Zell silt loams, 6 to 9 percent slopes	5	8	26	39	12	18	27	39	6	10	35	52	1. 4	2. 0
Hamar loamy fine sand	6	8	28	42	12	20	19	35	8	11	26	48	1. 6	2. 6
Hamar fine sandy loam	6	9	30	45	16	23	21	38	9	13	28	50	1. 6	2. 6
Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes	7	10	37	51	17	28	29	44	10	15	39	59	1. 5	2. 5
Hecla loamy fine sand, 0 to 3 percent slopes	5	8	26	40	10	16	20	30	7	10	26	39	1. 4	2. 2
Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	6	9	27	43	11	18	20	31	7	11	26	43	1. 5	2. 4
Kranzburg silt loam, 0 to 2 percent slopes	8	12	42	59	17	26	34	48	9	14	45	64	1. 9	2. 5
Kranzburg silt loam, 2 to 6 percent slopes	8	11	39	55	16	24	32	47	8	14	42	62	1. 8	2. 3
Kranzburg silt loam, 6 to 9 percent slopes, eroded	6	8	29	42	12	17	29	42	6	10	39	43	1. 6	2. 1
Kranzburg-Aberdeen silt loams, 0 to 2 percent slopes	7	11	37	53	16	26	30	44	8	13	41	59	1. 7	2. 5
Kranzburg-Aberdeen silt loams, 2 to 6 percent slopes	7	10	35	51	16	25	28	42	8	13	37	56	1. 6	2. 3
Lamoure silty clay loam	8	11	40	55	14	23	30	43	9	15	40	58	1. 8	2. 8
Ludden silty clay	5	9	27	44	14	23	25	39	7	14	33	52	1. 6	2. 6
Maddock loamy fine sand, 2 to 6 percent slopes	4	7	22	36	9	14	15	25			20	30	1. 3	1. 8
Oldham silty clay loam	6	9	30	45	15	25	25	44	7	15	34	58	1. 5	3. 0
Oldham silty clay loam, saline	4	6	20	28	10	18	19	26	6	12	25	35	1. 5	2. 4
Parnell silty clay loam	6	10	30	45	12	21	22	36	9	14	30	48	1. 6	2. 4
Peever clay loam, 0 to 2 percent slopes	7	10	35	52	15	24	26	45	8	14	35	60	1. 5	2. 3
Peever clay loam, 2 to 6 percent slopes	6	10	33	50	13	21	25	43	7	13	33	58	1. 5	2. 3
Peever clay loam, 6 to 9 percent slopes	5	8	27	41	11	19	21	38	5	10	29	51	1. 4	2. 0
Peever-Hamerly complex, 0 to 2 percent slopes	6	10	33	51	14	22	26	45	8	13	37	58	1. 4	2. 3
Playmoor silty clay loam	4	6	20	30	10	18	14	25	7	12	25	35	1. 7	2. 4
Poinsett-Forman complex, 2 to 6 percent slopes	7	11	35	55	13	22	26	45	7	14	35	60	1. 6	2. 3
Poinsett-Waubay silty clay loams, 0 to 2 percent slopes	8	12	42	62	18	28	33	50	10	17	44	67	1. 7	2. 5
Poinsett-Waubay silty clay loams, 2 to 6 percent slopes	8	11	39	59	15	24	30	49	9	16	40	65	1. 6	2. 4
Renshaw-Fordville loams, 0 to 3 percent slopes	4	6	21	35	11	17	18	27	6	11	24	33	. 9	1. 3
Renshaw-Fordville loams, 3 to 6 percent slopes	3	5	17	27	9	15	15	23	5	9	20	31	. 8	1. 2
Sieche loam, 6 to 15 percent slopes														
Sinai silty clay, 0 to 3 percent slopes	7	11	36	53	18	25	32	48	11	17	43	64	1. 8	2. 7
Sinai silty clay, 3 to 6 percent slopes	6	10	33	40	16	23	30	45	10	15	42	61	1. 7	2. 5
Sinai silty clay, 6 to 9 percent slopes	5	9	28	45	14	21	28	42	7	13	39	57	1. 6	2. 3
Stirum-Ulen fine sandy loams	3	5	15	23	9	16	16	24	5	8	21	30	1. 1	1. 6
Swenoda fine sandy loam, 0 to 2 percent slopes	7	10	35	50	14	26	22	33	7	14	30	45	1. 5	2. 0
Swenoda fine sandy loam, 2 to 6 percent slopes	6	9	32	47	13	23	20	31	6	13	28	42	1. 4	1. 9

TABLE 2.—*Estimated average yields per acre of principal dryfarmed crops under two levels of management*—Continued

Soil	Corn ensilage		Corn		Spring wheat		Barley		Flax		Oats		Alfalfa	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Swenoda-Larson complex, 0 to 2 percent slopes	6	9	30	43	12	22	20	29	6	8	26	40	1. 3	1. 7
Tonka silt loam	6	10	32	48	13	22	24	38	10	15	32	50	1. 9	2. 6
Ulen fine sandy loam	5	7	24	35	13	20	21	35	8	12	29	47	1. 5	2. 0
Ulen-Stirum fine sandy loams	4	6	19	29	11	18	18	30	7	10	25	40	1. 3	1. 8
Vallers loam	3	6	15	30	10	20	20	34	8	11	28	45	1. 2	2. 4

Sudangrass is used extensively for temporary summer pasture, but perennial grasses are desirable for permanent pastures. Bunch and tufted grasses, such as crested wheatgrass and green needlegrass, are unsuitable on slopes of more than 6 percent, unless they are planted with sod-forming grasses.

In the following paragraphs, the soils of Marshall County are grouped into pasture suitability groups. Only those soils suited to tame pasture are listed. The names of the series represented are mentioned, but this does not mean that all the soils of a given series are in that group. To find the pasture group of a given mapping unit, refer to the "Guide to Mapping Units."

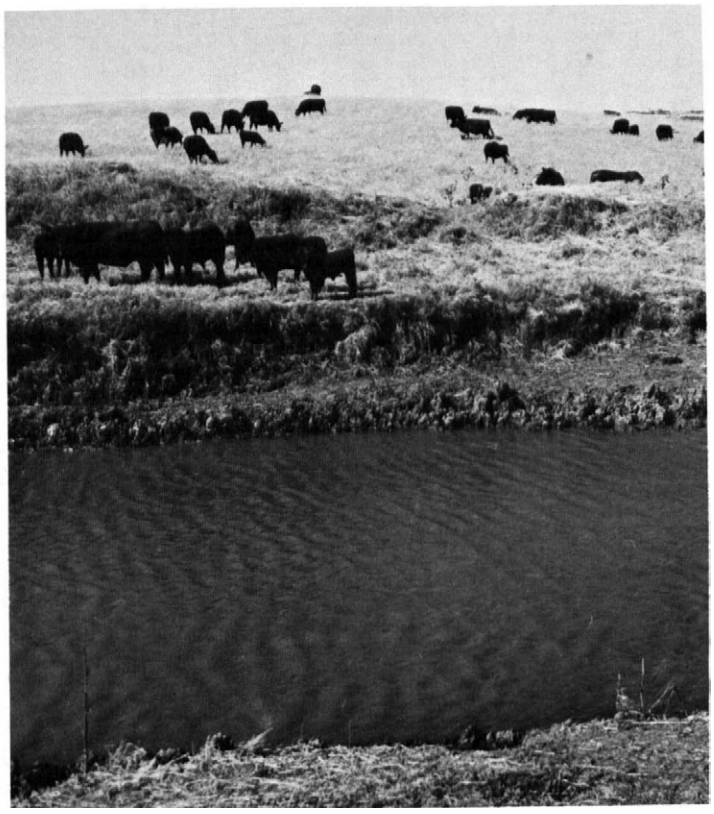

Figure 26.—Stock-water dugout helps distribute grazing in pasture on Forman-Aastad loams, 9 to 15 percent slopes.

PASTURE GROUP A

In this group are sandy to clayey soils of the Colvin, Divide, Dovray, Hamar, Lamoure, Ludden, Oldham, Parnell, Tonka, and Vallers series. These soils have above-average moisture regimes because they have a permanent water table, are flooded by streams, or receive runoff from adjacent soils. Drainage has been established, and moisture supplies are sufficient to produce 2 to 3 times the amount of forage produced by well-drained upland soils.

Suitable grasses and legumes are smooth bromegrass, intermediate wheatgrass, big bluestem, creeping foxtail, indiangrass, switchgrass, alfalfa, and reed canarygrass.

PASTURE GROUP B

In this group are undrained areas of somewhat poorly drained through very poorly drained, sandy, loamy, and clayey soils of the Arveson, Benoit, Colvin, Lamoure, Ludden, Oldham, Parnell, Tonka, Vallers and Venlo series. These soils have high water tables or are flooded, and water ponds long enough to limit the kinds of adapted grasses. Fall is the most suitable time for seedbed preparation.

Suitable grasses are reed canarygrass, creeping foxtail, and western wheatgrass. Once drainage is established on these soils, they then have the same suitability for pasture as soils in pasture group A.

PASTURE GROUP C

In this group are soils of the Larson and Stirum series. These soils have a surface layer of loam and fine sandy loam over a claypan subsoil. They have a relatively high content of sodium in the subsoil or underlying material and release moisture slowly to plants. Permeability is slow or moderately slow, and fertility is low.

Suitable grasses and legumes are crested wheatgrass, pubescent wheatgrass, green needlegrass, intermediate wheatgrass, western wheatgrass, and alfalfa.

PASTURE GROUP D

In this group are silty and loamy soils of the Arvilla, Estelline, Fordville, and Renshaw series. These soils are underlain by sand and gravel at shallow or moderate depths. Permeability is rapid in the underlying sand and gravel. Available water capacity is low or moderate, and the soils are droughty.

Suitable grasses and legumes are smooth bromegrass,

intermediate wheatgrass, crested wheatgrass, pubescent wheatgrass, and alfalfa. Arvilla and Renshaw soils are best suited for crested wheatgrass and pubescent wheatgrass.

PASTURE GROUP E

In this group are deep, silty and loamy soils of the Aberdeen, Harmony, and Peever series. These soils have a surface layer of silty clay loam or clay loam and a subsoil of silty clay or heavy clay loam. Permeability is generally slow, but it is moderate in the Harmony soil. Available water capacity is moderate or high, but the clayey subsoil releases moisture slowly to plants, and root development is restricted. The soils are slow to dry in spring, but they are commonly dry late in summer.

Suitable grasses and legumes are big bluestem, green needlegrass, intermediate wheatgrass, indiangrass, smooth bromegrass, switchgrass, and alfalfa.

PASTURE GROUP F

In this group are deep, well-drained to somewhat poorly drained, loamy and silty soils of the Bearden, Edgeley, Forman, Great Bend, Hamerly, Kranzburg, Poinsett, and Sieche series. Fertility is medium or high. Available water capacity is generally high, but it is moderate in the Edgeley soil. Soil-water relationships are favorable for plants, and growth is limited mainly by periodic shortages of moisture that are common to the climate of the county.

Suitable grasses and legumes are smooth bromegrass, intermediate wheatgrass, big bluestem, green needlegrass, indiangrass, switchgrass, and alfalfa.

PASTURE GROUP G

In this group are deep, calcareous, loamy and silty soils of the Buse and Zell series. These soils have a relatively thin surface layer. Fertility is low or medium. Available water capacity is moderate or high. The soils respond to applications of fertilizer.

Suitable grasses and legumes are smooth bromegrass, intermediate wheatgrass, crested wheatgrass, pubescent wheatgrass, and alfalfa.

PASTURE GROUP H

In this group are deep, loamy and sandy soils of the Embden, Hecla, Maddock, Swenoda, and Ulen series. These soils have a surface layer of fine sandy loam or loamy fine sand and a subsoil and underlying material generally of fine sandy loam to fine sand. The Swenoda soil, however, is silty at depths between 40 and 60 inches. Available water capacity ranges from low to high, and permeability ranges from moderate through rapid. These soils trap moisture efficiently, but they blow easily if a vegetative cover is lacking.

Suitable grasses and legumes are big bluestem, indiangrass, switchgrass, intermediate wheatgrass, smooth bromegrass, and alfalfa.

PASTURE GROUP I

In this group are deep, well-drained, clayey soils of the Sinai series. These soils commonly crack when dry and swell when wet. Fertility is high. Available water capacity is high, but permeability is slow. The clayey subsoil restricts the development of plant roots and the penetration of moisture.

Suitable grasses and legumes are smooth bromegrass, intermediate wheatgrass, green needlegrass, and alfalfa.

PASTURE GROUP J

In this group are deep, poorly drained, silty soils of the Oldham and Playmoor series. These soils have a high water table, and they have a high content of salt at shallow depths. Only plants that tolerate salts and wetness are suitable.

Suitable grasses are tall wheatgrass and western wheatgrass.

PASTURE GROUP K

In this group are deep, moderately well drained or well drained, loamy and silty soils of the Aastad, Beotia, and Waubay series. Fertility and available water capacity are high. These soils receive additional moisture because of runoff from adjacent soils. The increased moisture supply is sufficient to produce more forage than adjacent upland soils.

Suitable grasses and legumes are creeping foxtail, intermediate wheatgrass, big bluestem, smooth bromegrass, switchgrass, indiangrass, reed canarygrass, and alfalfa.

Use of the Soils for Range [5]

Prior to its settlement, most of Marshall County was covered with prairie vegetation. Except for some bur oak groves in the eastern part of the county and scattered groves of trees in protected ravines and coulees, the vegetation was dominantly grass.

As the county was settled, much of this grassland was broken and farmed. Usually the best soils were selected for cultivation. Because of this selectivity, the soils remaining in native vegetation are, for the most part, steep, shallow, wet, or stony. For these or other reasons they are not well suited to cultivation.

Approximately 170,000 acres, or 30 percent of the land area of Marshall County, is now range. The percentage of range is highest in the Maddock-Serden association because the hazards associated with cultivation of the sandy soils are more severe there than in other associations. The percentage of range is also high in the Forman-Aastad-Buse association where the topography and scattered stony areas make the soils less suitable for cultivation.

Much of the range in Marshall County is in scattered and rather small tracts, and most of it has been heavily grazed for a long time. This long and heavy grazing has brought about changes in the plant cover. These changes make appraisal of the productive potential difficult, and range site and range condition techniques are required.

Range sites and condition classes

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants. A range site is the product of all environmental factors responsible for its development. In the absence of abnormal disturbance and physical site

[5] By C. M. SCHUMACHER, range conservationist, Soil Conservation Service.

deterioration, it supports a plant community of species that differs from other range sites in the kind or proportion of species or in total annual yield.

Range condition is the present state of vegetation of a range site in relation to the climax plant community for that site (*3*). The terms "climax" and "natural," as applied to the potential of range sites, are considered to be synonymous. Range condition classes are an expression of the degree to which the present composition, expressed in percent, has departed from that of the climax plant community of a range site.

Four range condition classes are recognized: excellent, good, fair, and poor. A range is in excellent condition if 76 to 100 percent of the vegetation is that of the climax vegetation for that site. It is in good condition if the percentage is 51 through 75; in fair condition if the percentage is 26 through 50; and in poor condition if the percentage is 25 or less.

The purpose of determining range condition is to provide an approximate measure of changes that have taken place in the plant cover, to provide thereby a basis for predicting the nature and direction of plant community changes to be expected from management.

The range condition of an area within a range site is determined by comparing present vegetation with the climax plant community indicated by the range condition guide for the site. To facilitate this process, components of the vegetation are segregated according to their response to the kind of grazing use on specific range sites. These component categories are decreaser, increaser, and invader plants.

Decreaser plants are species in the climax plant community that decrease in relative abundance when such a community is subjected to continued excessive grazing. Increaser plants are species in the climax plant community that usually increase in relative abundance when the community is subjected to continued excessive grazing. Invader plants are not members of the climax plant community for the site. They invade the community as a result of various kinds of disturbance.

Descriptions of range sites

The soils of Marshall County are grouped into 13 range sites, which are described in the following paragraphs. In each description are shown important characteristics and properties of the site, principal plants, and estimates of yields. The estimates are for range in excellent condition. They represent the entire annual growth, 70 to 90 percent of which is made up of species that provide the major source of forage for cattle.

The names of the soil series represented are mentioned in each description, but this does not mean that all the soils in a given series are in that site. To find the range site in which a soil is placed and the page on which it is described, turn to the "Guide to Mapping Units."

WET LAND RANGE SITE

This site consists of the land type, Wet alluvial land, and poorly drained or very poorly drained soils of the Benoit, Oldham, Parnell, and Venlo series. The water table is at a depth of less than 3 feet during much of the growing season. Soils in this range site are too wet and too poorly aerated for big bluestem, but they have the potential to produce a luxuriant stand of water-tolerant grasses.

Prairie cordgrass, reedgrass, reed canarygrass, or rivergrass are the main species on these soils. Slough sedge makes up 25 percent of the vegetation in places. Shrubs and trees, such as indigobush amorpha and willows, are in some areas.

If areas are continually overused, the stand of climax grasses loses vigor and thins out. Sedges, rushes, Kentucky bluegrass, or inland saltgrass then increase in abundance. These plants are either shorter or less palatable than the climax species, so the loss in productivity is great. Mechanical treatments for range improvement are not feasible, and range seeding is difficult on soils in this site.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 5,500 pounds per acre in an unfavorable year to 6,500 pounds per acre in a favorable year.

SUBIRRIGATED RANGE SITE

This site consists of the land type Sandy lake beaches and the somewhat poorly drained through very poorly drained soils of the Arveson, Colvin, Hamar, Lamoure, Playmoor, Stirum, and Vallers series. The water table rises to the surface of the soils early in the growing season but recedes to a depth of about 3 feet or more during part of this season. Although the soils in this range site are somewhat wet, they are aerated sufficiently to grow big bluestem. They have the potential to produce a luxuriant stand of tall prairie grasses. Big bluestem is the main grass where the soils are in excellent condition, and, in places, it is 75 to 90 percent of the vegetation. Other grasses in lesser amounts are switchgrass, indiangrass, Canada wildrye, and prairie cordgrass. Western wheatgrass and inland saltgrass are increasers and are present in small amounts. Kentucky bluegrass is a minor part of the understory. Also present are sedges, forbs, and the shrub indigobush amorpha.

If areas are continually overused, western wheatgrass, inland saltgrass, and Kentucky bluegrass increase in abundance and replace the climax species. Eventually, if overuse is not curtailed, Kentucky bluegrass or inland saltgrass and an overstory of weeds become dominant. Mechanical treatments, such as furrowing and pitting, are not feasible on soils in this site.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 4,500 pounds per acre in an unfavorable year to 5,500 pounds per acre in a favorable year.

OVERFLOW RANGE SITE

This site consists of the land type Loamy alluvial land and moderately well drained through poorly drained soils of the Aastad, Ludden, and Oldham series. Fertility is medium or high in the soils. Available water capacity is moderate or high. Permeability ranges from moderate through very slow. These soils receive additional moisture because of stream overflow or runoff from adjacent, sloping soils. The additional moisture is sufficient to give the site the potential to produce dense stands of tall and mid grasses.

Tall grasses make up the climax vegetation, and big

bluestem is dominant. In many places big bluestem makes up 65 to 85 percent of the vegetation. Other grasses are green needlegrass, porcupine, indiangrass, switchgrass, Canada wildrye, and little bluestem. Western wheatgrass and side-oats grama are the main increasers. Also present are Kentucky bluegrass, sedges, forbs, and the shrub, leadplant amorpha.

If areas are continuously overused, western wheatgrass and Kentucky bluegrass increase and replace the climax species. Eventually, if overuse is not curtailed, Kentucky bluegrass becomes dominant.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,000 pounds per acre in an unfavorable year to 4,500 pounds per acre in a favorable year.

CLOSED DEPRESSION RANGE SITE

This site consists of poorly drained soils of the Tonka series. These soils are in closed depressions where water from adjacent soils collects. In some years areas are excessively wet from ponded water, but during extended dry periods they are dry. Permeability is slow. The plant cover lacks the stability generally associated with climax vegetation because of alternating periods of wetness and dryness.

Big bluestem, switchgrass, Canada wildrye, reedgrass, prairie cordgrass, indiangrass, and western wheatgrass are important grasses on this site. In places western wheatgrass is dominant. Kentucky bluegrass, sedges, and forbs are also present.

Overgrazing and the resultant trampling aggravate the conditions caused by poor drainage. Kentucky bluegrass, inland saltgrass, sedges, and rushes increase and replace the tall grasses. The kinds and amounts of invading weeds depend on the current wetness of the disturbed surface. During wet periods smartweed becomes abundant, but during dry periods such weeds as curlycup gumweed invade the site. Mechanical treatments, such as furrowing and pitting, are not feasible on the soils in this site.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,000 pounds per acre in an unfavorable year to 4,000 pounds per acre in a favorable year.

SANDS RANGE SITE

This site consists of deep, moderately well drained through excessively drained, sandy soils of the Hecla, Maddock, and Serden series. These soils have a surface layer of loamy fine sand or sand. Fertility is medium or low, and available water capacity is low or moderate. These loose sandy soils readily absorb all the precipitation that falls on the site.

Warm-season grasses, mainly sand bluestem, big bluestem, and little bluestem, are the climax vegetation. Other warm-season decreasers in lesser amounts are indiangrass and switchgrass. Lesser amounts of cool-season grasses include Canada wildrye and prairie junegrass. Prairie sandreed is the principal increaser. Also present are forbs and woody plants.

If areas are continually overused, the bluestems decrease and are replaced by prairie sandreed. If the prairie sandreed is grazed too closely, bare areas appear, and soil blowing becomes a hazard. Mechanical treatment measures, such as contour furrowing and pitting, are not feasible on soils in this site.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,400 pounds per acre in an unfavorable year to 3,200 pounds per acre in a favorable year.

SANDY RANGE SITE

This site consists of deep, loamy soils of the Embden, Swenoda, and Ulen series. These soils have a surface layer of fine sandy loam. Fertility is medium or low. Permeability is moderate through rapid, and available water capacity ranges from low through high.

A mixture of mid and tall, warm-season grasses makes up most of the climax vegetation. Little bluestem, sand bluestem, and big bluestem are the main grasses. Small amounts of cool-season decreasers, mainly Canada wildrye and prairie junegrass, are in some areas. The cool-season increasers—needle-and-thread and western wheatgrass—are next in importance. Blue grama and side-oats grama are present in small amounts.

If areas are continually overused, the bluestems decrease and are replaced by prairie sandreed, needle-and-thread, western wheatgrass, and side-oats grama. Eventually, if overuse is not curtailed, Kentucky bluegrass and blue grama become dominant.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,300 pounds per acre in an unfavorable year to 3,200 pounds per acre in a favorable year.

SILTY RANGE SITE

This site consists of deep, loamy and silty soils of the Aastad, Bearden, Beotia, Divide, Edgeley, Estelline, Fordville, Forman, Great Bend, Hamerly, Kranzburg, Poinsett, and Waubay series. These soils are well drained or moderately well drained, except in places the Divide and Hamerly soils are somewhat poorly drained. The soils have a surface layer of loam or silt loam and a subsoil of loam to silty clay loam. Available water capacity is generally moderate or high, but it is low or moderate in the Divide and Fordville soils. Soil-water relationships are favorable for the growth of range plants.

A mixture of tall and mid grasses that is characteristic of the transition between true and mixed prairie makes up the climax vegetation. Green needlegrass and western wheatgrass are important species, as are big bluestem and little bluestem, which are warm-season decreasers. Also present are blue grama, side-oats grama, and the shrub leadplant amorpha.

If areas are continually overused, big bluestem and little bluestem are replaced by western wheatgrass and needle-and-thread. Eventually, if overuse is not curtailed, blue grama becomes dominant.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,400 pounds per acre in an unfavorable year to 3,200 pounds per acre in a favorable year.

CLAYEY RANGE SITE

This site consists of deep, loamy or clayey soils of the Aberdeen, Dovray, Peever, and Sinai series. These are well drained or moderately well drained soils, but in

places the Aberdeen soil is somewhat poorly drained and the Dovray soil is poorly drained. These soils have a subsoil of silty clay, clay, or heavy clay loam. Permeability is generally slow or very slow, but it is moderate in the Harmony soil. Available water capacity is moderate or high. The clayey subsoil is somewhat restrictive to the development of plant roots, but soil-water relationships are mostly favorable for the growth of range plants.

A mixture of tall and mid grasses that is characteristic of the transition between true and mixed prairie makes up the climax vegetation. Western wheatgrass and green needlegrass are the major grasses along with lesser amounts of the warm-season decreasers, big bluestem and little bluestem. Also present is an understory of short grasses.

If areas are continually overused, big bluestem, little bluestem, and green needlegrass are replaced by western wheatgrass. Eventually, if overuse is not curtailed, western wheatgrass is replaced by short grasses.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,200 pounds per acre in an unfavorable year to 2,900 pounds per acre in a favorable year.

THIN UPLAND RANGE SITE

This site consists of well-drained, loamy and silty soils of the Buse, Kloten, and Zell series. These soils have a relatively thin surface layer of loam or silt loam, and, except for Kloten soils, they are calcareous at or near the surface. Except for the Kloten soil, the underlying material is loamy glacial till or lacustrine silts. Kloten soils are shallow to bedded shale. Available water capacity is generally moderate or high, but it is low or very low in the Kloten soil. Runoff is medium or rapid.

Little bluestem is the major grass in the climax vegetation. Other important decreasers are big bluestem and green needlegrass. Side-oats grama, western wheatgrass, needle-and-thread, and blue grama are important increasers. Forbs and shrubs, such as leadplant amorpha, are important in places.

If areas are continually overused, the decreasers are replaced by needle-and-thread and side-oats grama. Eventually, if overuse is not curtailed, blue grama and other short grasses increase.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,000 pounds per acre in an unfavorable year to 2,700 pounds per acre in a favorable year.

SHALLOW TO GRAVEL RANGE SITE

This site consists of somewhat excessively drained or excessively drained, loamy soils of the Arvilla and Renshaw series. These soils are shallow over sand and gravel. Available water capacity is low, and the soils are droughty. Permeability in the underlying sand and gravel is rapid.

A mixture of mid and short grasses makes up the climax vegetation, and needle-and-thread is the dominant grass. Blue grama, hairy grama, and threadleaf sedge are important short-growing plants. Forbs, such as black samson, and shrubs are present in some areas.

If areas are continually overused, the short grasses increase, leaving a short-grass sod that has an overstory of unpalable weeds. Mechanical treatments, such as contour furrowing and pitting, are not feasible on this site.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,500 pounds per acre in an unfavorable year to 2,300 pounds per acre in a favorable year.

CLAYPAN RANGE SITE

This site consists of deep, moderately well drained, loamy soils of the Larson series. This soil has a dense claypan subsoil. Available water capacity is high, but permeability is slow, and the dense claypan releases moisture slowly to plants.

A mixture of mid and short grasses makes up the climax vegetation. Western wheatgrass is a major grass, but the cool-season grasses, needle-and-thread and green needlegrass, are also present. Blue grama is the main short grass.

If areas are continually overused, the mid grasses are replaced by short grasses. Eventually, if overuse is not curtailed, there is some bare ground during dry cycles and many weeds during wet cycles.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,600 pounds per acre in an unfavorable year to 2,400 pounds per acre in a favorable year.

THIN CLAYPAN RANGE SITE

This site consists of deep, somewhat poorly drained, silty soils of the Exline series. These soils have a thin surface layer of silt loam. The subsoil is a dense claypan. Salts are in the lower part of the subsoil at depths of less than 20 inches. Permeability is very slow, and available water capacity is low or moderate. Runoff is very slow.

A mixture of short and mid grasses makes up the climax vegetation. Western wheatgrass is the main decreaser, and blue grama is the main increaser. Small amounts of pricklypear cactus are commonly present.

If areas are continually overused, the mid grasses are replaced by blue grama, buffalograss, and inland saltgrass. Eventually, if overuse is not curtailed, there is considerable bare ground during dry periods and many weeds during wet periods. Mechanical treatment is not feasible, and the chance for success of range seeding is very poor.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 900 pounds per acre in an unfavorable year to 1,700 pounds per acre in a favorable year.

VERY SHALLOW RANGE SITE

This site consists of excessively drained, loamy and gravelly soils of the Sioux series. These soils are underlain by loose sand and gravel at a depth of less than 10 inches. Permeability is rapid, and the soils are very droughty.

A mixture of mid and short grasses makes up the climax vegetation. Needle-and-thread is the main mid grass. Blue grama, hairy grama, and threadleaf sedge are the main short-growing plants.

If areas are continually overused, this site deteriorates rapidly to grama grasses and threadleaf sedge. Even-

tually, if overuse is not curtailed, the plant cover thins out, and there is a strong risk of erosion. Mechanical treatment is not feasible, and the chance for success of range seeding is very poor.

If this range site is in excellent condition, the total annual yield of air-dry herbage ranges from 900 pounds per acre in an unfavorable year to 1,700 pounds per acre in a favorable year.

Use of the Soils for Windbreaks [6]

This section gives information about the planting and care of windbreaks. Two types of trees grow in Marshall County: native trees and trees planted for farmstead and field windbreaks.

The native trees are mostly on coulees along the eastern side of the Prairie Coteau in the eastern part of the county, on the shores of natural lakes, and in clumps in low, level areas that have a high water table. This timberland is most valuable for recreational areas, watershed protection, and wildlife habitat.

The native trees and shrubs are dominantly ash, boxelder, oak, peach-leaved willow, chokeberry, and plum. In areas where the water table is high in the northwestern part of the county, cottonwoods and willows are dominant.

In Marshall County trees are planted mainly to establish farmstead (fig. 27) and field windbreaks. Nearly every farmstead in the county has some trees around it, but supplemental planting is generally needed to make a windbreak that effectively protects livestock and keeps snow from drifting into yards. Field windbreaks protect crop land from the wind and hold snow on the fields (fig. 28).

Evergreens grow well on such soils as the Aberdeen, Beotia, Embden, Forman, Great Bend, Hamar, Harmony, Hecla, and Poinsett soils. More windbreaks of evergreens are needed because they provide year-round protection against wind and effectively hold back drifting snow. Also, insect-eating birds prefer evergreens for nesting.

Field windbreaks have definite value in the county, especially on the Embden, Hamar, Hecla, and Ulen soils, where soil blowing is a hazard. Narrow windbreaks, mainly the single-row type (fig. 29), are needed in the intensively farmed areas of the county, where the soils are suitable for adequate tree growth.

Windbreak planting sites need careful preparation, and

[6] By ELMER L. WORTHINGTON, woodland conservationist, Soil Conservation Service.

Figure 28.—Field windbreaks in an area of Embden fine sandy loam, 0 to 2 percent slopes, and Hecla loamy fine sand, 0 to 3 percent slopes.

Figure 27.—Farmstead windbreak in an area of Poinsett-Waubay silty clay loams, 0 to 2 percent slopes.

Figure 29.—Single-row field windbreak of 4-year-old Siouxland cottonwood in an area of Beotia silt loam, 0 to 2 percent slopes.

the trees need to be protected from weeds, insects, diseases, and grazing. Information about the establishment and care of trees can be obtained from the local office of the Soil Conservation Service.

To assist in the planning and establishment of windbreaks, the soils of Marshall County are placed in windbreak suitability groups. These groups identify special management, site performance, and the suitability of various species.

Table 3 can be used as a guide in planning windbreaks. It lists the species suitable for windbreaks and indicates their probable performance in each windbreak suitability group. Tree heights listed are based on measurements and observations made on windbreaks that are at least 20 years old and that have been given adequate care. The criteria for the condition classes are as follows:

Good. One or more of the following conditions apply. Leaves or needles are normal in color and growth; small amounts of deadwood are within the live crowns; evidence of disease, insect, and climatic damage is limited; or slight evidence of suppression or stagnation may exist.

Fair. One or more of the following conditions apply. Leaves or needles are abnormal in color and growth; substantial amounts of deadwood are within the live crowns; evidence of moderate disease, insect, or climatic damage is obvious; definite suppression or stagnation exists; or the current year's growth is less than normal.

Poor. One or more of the following conditions apply. Leaves or needles are very abnormal in color and growth; very large amounts of deadwood are within the live crowns; evidence of extensive disease, insect, and climatic damage is obvious; severe stagnation, suppression, or decadence exists; or the current year's growth is negligible.

Windbreak suitability groups

The windbreak suitability groups described in the paragraphs that follow evaluate the soils of Marshall County for trees. The groups are not numbered consecutively, because not all of the groups in the statewide system are applicable to the county. The names of the soil series are mentioned in the description of each group, but this does not mean that all soils of a given series are in that group. To find the windbreak suitability group of a given soil, refer to the "Guide to Mapping Units."

WINDBREAK GROUP 1

In this group are deep, well-drained through somewhat poorly drained, loamy and silty soils of the Aastad, Bearden, Embden, Hamerly, Swenoda, and Waubay series. These soils have a surface layer and subsoil that range from fine sandy loam through silty clay loam. Fertility is medium or high. Available water capacity generally is high in these soils, but it is moderate or high in Embden soils. The soils of this group receive additional moisture in the form of runoff from adjacent soils.

TABLE 3.—*Suitability of selected trees and shrubs for*

[Condition and height are estimated at 20 years of age. No height range is given for poor

Species	Windbreak group 1		Windbreak group 2		Windbreak group 3	
	Condition	Height	Condition	Height	Condition	Height
		Ft.		*Ft.*		*Ft.*
Trees:						
American elm	Good	24–28	Good	22–26	Good	20–22
Black Hills spruce	Good	24–30	Good	20–24	Good	24–28
Box elder	Fair	20–22	Fair	18–20	Fair	20–22
Chinkota elm	Good	32–36	Good	24–28	Good	30–32
Colorado blue spruce	Good	24–30	Good	20–24	Good	24–28
Cottonwood	Good	35–40	Good	32–36	Poor	
Crabapple	Good	18–20	Good	16–18	Good	15–17
Dropmore elm	Good	32–36	Good	24–28	Good	30–32
Eastern redcedar	Good	15–18	Good	14–16	Good	13–15
Golden willow	Good	32–35	Good	30–34	Poor	
Green ash	Good	23–27	Good	20–24	Good	20–24
Hackberry	Good	23–27	Good	22–26	Good	20–24
Harbin pear	Good	16–18	Good	14–16	Good	15–17
Ponderosa pine	Good	24–30	Good	20–22	Good	22–26
Rocky Mountain cedar	Good	15–18	Good	14–16	Good	13–15
Siberian elm	Good	32–36	Good	24–28	Good	30–32
White willow	Good	32–35	Good	30–34	Poor	
Shrubs:						
Buffaloberry	Good	8–10	Fair	6–8	Good	7–9
Caragana	Good	9–11	Fair	7–9	Good	9–10
Chokecherry	Good	12–14	Fair	9–11	Good	9–12
Cotoneaster	Good	6–7	Fair	5–6	Good	5–6
Honeysuckle	Good	8–10	Good	6–8	Good	7–9
Lilac	Good	7–8	Good	5–6	Good	6–7
Nanking cherry	Good	5–7	Fair	4–5	Fair	5–6
Plum	Good	8–9	Good	5–6	Good	8–9
Russian-olive	Fair	16–20	Fair	14–16	Fair	15–18

The moisture regime is among the most favorable in the county for the planting and survival of trees.

Soils in this group are well suited to farmstead and feedlot windbreaks. They also are well suited to recreational uses and to wildlife plantings.

WINDBREAK GROUP 2

In this group are deep, moderately well drained through poorly drained, loamy or clayey soils of the Colvin, Divide, Dovray, Hamar, Hecla, Lamoure, Oldham, Ulen, and Vallers series. These soils have a water table at a depth of less than 6 feet during much of the growing season and some undrained areas are excessively wet for short periods. Adapted trees and shrubs grow well because of the abundant supply of available moisture, but the shallow depth to the water table limits root development.

Soils in this group are well suited to windbreaks, recreational use, and wildlife plantings. Artificial drainage helps to improve suitability for trees and shrubs.

WINDBREAK GROUP 3

In this group are deep, well drained or moderately well drained, nearly level to strongly sloping and rolling, silty and loamy soils of the Beotia, Forman, Great Bend, and Kranzburg series. Permeability generally is moderate, but it is moderately slow in the underlying material of the Forman and Kranzburg soils. Available water capacity is high. Soil-water relationships are favorable for tree growth, but moisture is deficient during extended dry periods.

Soils in this group are well suited to windbreaks, recreational use, wildlife plantings, and beautification plantings. Site preparation for windbreaks includes fallowing during the year prior to planting. Contour plantings help to conserve needed moisture and control erosion on sloping soils of this group.

WINDBREAK GROUP 4

In this group are deep, nearly level to sloping, loamy or clayey soils of the Aberdeen, Harmony, Peever, Sieche, and Sinai series. These soils have a subsoil of silty clay, clay, or heavy clay loam. Available water capacity is moderate or high. Permeability generally is slow, but it is moderate in Harmony and Sieche soils. The clayey subsoil limits root development. The accumulations of salts in the lower part of the subsoil and underlying material of the Aberdeen soil also limit root development.

Soils in this group are moderately well suited to windbreaks. They also are suitable for recreational use, wildlife plantings, and beautification plantings, but the height of growth is less than desired in places. Fallowing is a necessary part of site preparation for windbreaks. Contour plantings help to conserve moisture and control erosion on sloping soils of this group.

windbreak plantings, by windbreak suitability groups

condition. Windbreak suitability group 10 is not suitable for windbreak plantings]

Windbreak group 4		Windbreak group 6		Windbreak group 7		Windbreak group 8		Windbreak group 9	
Condition	Height	Condition	Height	Condition	Height	Condition	Height	Condition	Height
	Ft.		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Fair	24–28	Fair	10–12	Poor		Fair	14–16	Poor	
Poor		Poor		Poor		Poor		Poor	
Poor		Poor		Poor		Poor		Poor	
Good	36–40	Fair	16–20	Poor		Fair	18–22	Fair	12–14
Poor		Poor		Poor		Poor		Poor	
Poor		Poor		Poor		Poor		Poor	
Fair	13–15	Fair	12–14	Poor		Poor		Poor	
Good	36–40	Fair	16–20	Poor		Fair	18–22	Fair	12–14
Good	15–17	Fair	9–11	Fair	9–11	Fair	9–11	Fair	6–8
Poor		Poor		Poor		Poor		Poor	
Fair	21–26	Fair	12–14	Poor		Fair	14–16	Fair	10–12
Fair	22–24	Fair	10–12	Poor		Fair	14–16	Poor	
Fair	13–15	Fair	11–12	Poor		Fair	7–9	Fair	5–7
Good	17–19	Fair	13–15	Fair	14–16	Fair	14–16	Fair	10–12
Good	15–17	Fair	9–11	Fair	9–11	Fair	9–11	Fair	6–8
Good	36–40	Fair	16–20	Poor		Fair	18–22	Fair	12–14
Poor		Poor		Poor		Poor		Poor	
Good	7–9	Fair	5–6	Poor		Fair	4–5	Fair	3–4
Fair	7–8	Fair	6–7	Poor		Fair	7–8	Fair	5–6
Good	10–12	Poor		Poor		Poor		Poor	
Good	6–7	Fair	4–5	Poor		Fair	5–6	Poor	
Good	8–10	Fair	5–7	Poor		Fair	6–8	Poor	
Fair	4–5	Fair	4–5	Poor		Fair	5–6	Fair	3–4
Fair	4–5	Poor		Poor		Poor		Poor	
Good	8–9	Poor		Poor		Fair	5–6	Poor	
Fair	16–22	Fair	9–12	Poor		Fair	14–16	Fair	8–10

WINDBREAK GROUP 6

In this group are well-drained, nearly level to strongly sloping, loamy and silty soils of the Edgeley, Estelline, and Fordville series. These soils are underlain by sand and gravel or by bedded shale. Available water capacity is moderate or low, and the soils are somewhat droughty.

Soils in this group are poorly suited to windbreaks. They are suited to wildlife plantings, recreational use, and beautification plantings if optimum growth is not a critical factor. Fallowing is a necessary part of site preparation for planting trees in windbreaks. Planting on the contour helps to conserve moisture.

WINDBREAK GROUP 7

Maddock loamy fine sand, 2 to 6 percent slopes, is the only soil in this group. This sandy soil is deep and well drained. Fertility is medium or low. Available water capacity is low, and permeability is rapid. The soil is susceptible to blowing.

The soil in this group is poorly suited to windbreaks. If special care is used, it is suitable for recreation, wildlife plantings, and beautification plantings. Fallowing is not recommended as a site preparation practice because of the hazard of soil blowing. Planting in sod or in furrows helps to avoid soil blowing.

WINDBREAK GROUP 8

In this group are deep, well-drained, gently undulating and undulating, loamy and silty soils of the Buse and Zell series. These soils are calcareous at or near the surface. Fertility is low or medium. Available water capacity is high. These soils are subject to erosion and soil blowing.

Soils in this group are moderately well suited to windbreaks and to recreational uses and wildlife plantings. Practices that help to control erosion and soil blowing are needed while the site is being prepared. Planting on the contour helps to control erosion and conserve needed moisture.

WINDBREAK GROUP 9

In this group are deep, nearly level, moderately well drained or poorly drained, loamy soils of the Larson and Stirum series. These soils have a claypan subsoil that restricts root development. Permeability is slow or moderately slow. Reaction in the subsoil and underlying material is moderately alkaline or strongly alkaline. The presence of sodium and other salts is unfavorable for many species.

Soils in this group are poorly suited to windbreak plantings. They can be used for other types of plantings where growth and vigor are less critical.

WINDBREAK GROUP 10

This group includes all soils that are too steep, too stony, or too wet for windbreak trees that are normally planted with machinery. These soils are in the Benoit, Buse, Exline, Renshaw, and Venlo series. Also in this group are soils that are too shallow, too wet, or have other soil characteristics that severely limit the growth of trees under normal management.

Many soils in this group can be used for wildlife plantings, recreational uses, and beautification plantings that are hand planted and given special care. Trees and shrubs for such plantings that are tolerant to the conditions present at a specific site need to be selected.

Use of the Soils for Wildlife [7]

Wildlife habitat is no less a product of the soil than crops, trees, or forage for grazing animals. The level of wildlife production depends on a balanced habitat that provides food, cover, and other requirements of a specific species of wildlife. Also, several kinds of soils may be needed to produce the various elements of habitat for some species of wildlife. The potential of the 11 soil associations in Marshall County to provide habitat for wildlife is discussed in the pages that follow.

The most important game species in the Maddock-Serden association is white-tail deer. Most of this association of sandy soils is in native grass and has scattered willow and cottonwood in low areas of minor soils. It provides favorable habitat for deer. Waterfowl are important in years that small areas of open water and emergent aquatic plants are abundant in low areas of minor soils. During these years blue geese and snow geese make migratory stops in the low areas, and the habitat is favorable for blue-winged teal. Of lesser importance are mourning doves and pheasants. The main predator is the coyote.

The Embden-Hecla-Ulen association has good potential for pheasants and mourning doves and fair potential for deer and ducks. Sharp-tailed grouse and antelopes have low populations. Areas of cropland are intermingled with areas in native grass. Field windbreaks are fairly extensive. This pattern of land use is favorable for mourning doves and pheasants. The water table is high for part of the growing season in low areas of minor soils. These low areas are suitable habitat for white-tail deer and ducks. They are also suitable as a resting habitat for migratory blue geese and snow geese and as winter habitat for pheasants and other wildlife.

The Beotia-Great Bend association has a high potential for pheasants and mourning doves. This association of deep, well-drained, silty soils is one of the more intensively cultivated areas in the county. Farmstead, feedlot, and field windbreaks are common and provide protection and cover for pheasants. The pheasant population currently is suppressed by the intensive farming in the area and the lack of grazing management on small pastures. Rabbits and red foxes are also in the area. Low, wet areas along drainageways and drainage ditches provide a limited amount of habitat for waterfowl, shore birds, and fur-bearing animals. The small potholes of Tonka soils in this association attract breeding ducks and contribute to the total habitat for pheasants and mourning doves.

The population of pheasants is relatively high in the nearly level Harmony-Aberdeen-Exline association. Mourning doves, rabbits, and songbirds are the other main wildlife in this association. The potential for fish and waterfowl is low. Much of this association is cultivated, but farmstead windbreaks are smaller, and field windbreaks are few.

The Kranzburg association has the highest pheasant population in the county. Mourning doves also are abundant, and most of the gray partridges of the county are

[7] By JOHN F. FARLEY, biologist, Soil Conservation Service.

in this association. The ratio of cropland to grassland in the association is favorable for providing these game species with protection and cover. The grassland is mainly on the steep sides of entrenched drainageways that dissect the area and have stringers of native trees, which are single or in clumps. Protection and cover are also provided by windbreak plantings, which grow well in these soils. Impoundments of water on the entrenched drainageways attract breeding waterfowl. Some of the deeper impoundments, such as the one at Hickman Dam, provide potential for pond fisheries.

The Forman-Poinsett association has a good balance of habitat elements for pheasants and mourning doves. This association also has the highest potential in the county for fisheries in such lakes as Roy Lake (fig. 30), Clear Lake, Red Iron Lake, and Cottonwood Lake. In these lakes are such species as walleye, northern pike, yellow perch, large mouth bass, bluegill, and crappie. They also have abundant populations of bullheads with lesser amounts of suckers and rough fish. Other lakes in the association are of less value as fisheries, but they do provide food and rest for such waterfowls as redheads, canvasbacks, scaups, and greater Canada geese. High populations of diving ducks are in the area of Fort Sisseton Lakes. Lakes in this association also provide rookeries for cormorants and pelicans. The usefulness of the lakes in this association for fish and wildlife habitat is dependent on the conservation, use, and treatment of the watershed of these lakes.

The Sinai-Poinsett association has a high potential for pheasants, a good potential for mourning doves, and a fair potential for deer and ducks. Most of the area is cultivated. Native vegetation is on narrow areas along drainageways and in potholes where it helps provide balance to the wildlife habitat.

The Forman-Aastad-Buse association has many of the elements of a balanced habitat for many species of wildlife. About half of this association is cultivated, and most of the remainder is in native grass. Wooded coulees are along deeply entrenched drainageways in the northeastern part of the association. Also present in the association are many small lakes, sloughs, and potholes. This association has moderate to low populations of pheasants, a moderate number of mourning doves, and some gray partridges in the western part. A residual population of sharp-tailed grouse is in the northeastern part of the association in the vicinity of Marlowe Gulch. The many lakes, sloughs, and potholes support populations of minks, muskrats, raccoons, weasels, and skunks. Moderate populations of coyotes, foxes, and beavers are also present. The deer population is low, but a few mule deer are in the northwestern part of the association. The northeastern part of the association has excellent habitat for white-tail deer. Antelope plantings have been made on a trial basis. This association has a high potential for duck production. Gadwell ducks are the most prolific, but numerous other species are in the area. The lakes in this association are mostly shallow. Bullheads are dominant. Some of the lakes, however, have populations of such species as northern pike, walleye, largemouth bass, bluegill, yellow perch, and crappie.

Figure 30.—Aerial view of Roy Lake, one of the better fisheries in Marshall County.

The Peever-Forman-Tonka association has fair potential for pheasants and deer. This nearly level to sloping association is on foot slopes of the Sisseton Hills. It is dissected by drainageways whose headwaters are in the Forman-Aastad-Buse association. Deer migrate into the area along these drainageways. Most of the association not along drainageways is cultivated. A few small potholes are in the area, and narrow strips of bottom lands are along some of the drainageways. The amount of natural wetlands, however, is minor compared to some of the other associations.

The Renshaw-Fordville-Sioux association has elements of habitat similar to that of the Forman-Aastad-Buse association, but its potential for waterfowl production is lower. The soils of this association are underlain by gravel and have less potholes on uplands, away from the several lakes in the area, than do the soils of the Forman-Aastad-Buse association. Much of the area is in native grass, but cultivated fields are in places, and potential for pheasants and mourning doves is good. Wooded areas along the lakes and low areas of natural wetlands furnish habitat for deer, pheasants, mourning doves, and songbirds. Buffalo Lakes has northern pike and walleye and is consistently good for bullheads.

The Dovray-Ludden-Lamoure association consists of flat lowlands in the extreme northeastern part of the county. Although much of this area has poor natural drainage, much of it is cultivated. The lower and more poorly drained parts are suitable for duck production in wet years. This association has fair potential for deer and pheasants and no potential for fisheries.

Use of the Soils for Recreation [8]

Marshall County is a recreational center that offers many forms of outdoor activity to residents and visitors. Because of its relief and its good fishing and hunting,

[8] By JOHN B. FARLEY, biologist, Soil Conservation Service.

the eastern part of the county has an especially high potential for further development.

Four lakes—Roy, Clear, Buffalo, and Red Iron—provide the best fishing in the county. Ice fishing is popular in winter, and swimming, boating, and water-skiing (fig. 31) are water sports in summer. Most of the lakes have potential as tourist attractions that can benefit the economy of the county.

Small cottages surround the larger lakes. Most of the soils are suited to this type of summer home, but careful onsite investigation is needed to determine whether septic tanks and sewage disposal systems will function properly and whether the soil is suitable for building foundations. Pollution of ground-water supplies and lakes is a hazard in built-up areas near lakes.

The Prairie Coteau, or Sisseton Hills, has good potential for such winter sports as skiing, tobogganning, and snowmobiling.

This same area contains numerous wooded coulees that provide natural areas for hikes and nature studies. Sieche Hollow, one of the larger wooded coulees, is a State park that has hiking trails which have been developed to enable visitors to observe scenery and birds and other wildlife. Sieche Hollow also is noted for legends and for Indian history and culture.

Table 4 rates the degree and kind of limitation each soil in Marshall County has for selected types of recreation. The degrees of limitation are *none to slight*, *moderate*, and *severe*. If the limitation is *none to slight*, the soil is well suited to the specified use. If it is *moderate*, the soil is suited to the use but needs certain elements of management. A rating of *severe* means the soil is poorly suited to recreational use or needs careful management. Criteria used for these ratings are explained in the following paragraphs.

Ratings for camp areas are for areas used intensively for tents, small camp trailers, and the accompanying activities of outdoor living. Little or no site preparation is required. The sites should be suitable for unsurfaced parking as well as traffic by people, horses, and vehicles. The most suitable sites are well-drained, nearly level to gently sloping soils that are not subject to flooding.

Figure 31.—**Roy Lake in the Forman-Poinsett association is used for recreational activities.**

Ratings for picnic areas are for park-type areas that are used intensively. It is assumed that vehicular traffic will be confined to access roads.

Ratings for playgrounds are for areas designed for intensive play and for organized games that subject the soil to heavy foot traffic. The most suitable sites are on well-drained, nearly level to gently sloping soils that have a firm consistence and are not subject to flooding.

Paths and trails ratings are for use of the soils for bridle paths, hiking trails, and local footpaths. It is assumed that little or no soil will be moved. Soil features that affect trafficability, design, and maintenance are given special emphasis. Soils that have severe limitations, but that are desirable because the landscape is scenic, require special preparation and maintenance.

Further information on the use of soils for recreational development can be obtained from the local office of the Soil Conservation Service.

Engineering Uses of the Soils [9]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. Information contained in this section is valuable to planning commissions, town and country planners, town and city managers, sanitarians, land developers, and architects and realtors who are concerned with soils and their limitations in land-use planning and development. In this section are those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water-storage facilities, erosion-control structures, drainage systems, and sewage-disposal systems. Among the soil properties important in engineering are permeability, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction.

Most of the information in this section is presented in tables 5, 6, 7, and 8. The estimates and interpretations of soil properties in these tables can be used in:

1. Evaluating potential areas for residential, industrial, commercial, and recreational uses. Among factors that are concerns in selecting areas are depth to bedrock, seasonal water table, susceptibility to flooding, and permeability of the soil.
2. Evaluating potential locations for roads, highways, airports, pipelines, and underground cables. Among factors that are concerns in selecting locations are depth to bedrock, depth to water table, permeability of the soils, flooding frequency, and susceptibility to sliding.

[9] By ALFRED H. CHRISTENSON, agricultural engineer, Soil Conservation Service.

TABLE 4.—*Interpretations of the soils for use in recreation*

Mapping unit	Degree of limitations and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Aastad loam, 0 to 2 percent slopes	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Aberdeen-Exline silty clay loams, 0 to 2 percent slopes:				
Aberdeen soil	Moderate: slow permeability.	Moderate: texture	Moderate: slow permeability; texture.	Moderate: texture.
Exline soil	Severe: wetness; very slow permeability.	Moderate: wetness; texture.	Severe: wetness; very slow permeability.	Moderate: wetness; texture.
Arveson fine sandy loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Arvilla-Sioux loams, 9 to 25 percent slopes.	Moderate to severe: excessive slope.	Moderate to severe: excessive slope.	Severe: excessive slope.	Slight to moderate: excessive slope.
Bearden silt loam	Severe: wetness; slow permeability.	Moderate: wetness	Severe: wetness; slow permeability.	Moderate: wetness.
Bearden-Tonka silt loams, 0 to 3 percent slopes:				
Bearden soil	Moderate: wetness; slow permeability.	Moderate: wetness	Moderate: wetness; slow permeability.	Moderate: wetness.
Tonka soil	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.
Benoit and Divide loams:				
Benoit soil	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Divide soil	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Beotia silt loam, 0 to 2 percent slopes	None to slight	None to slight	None to slight	None to slight.
Beotia silt loam, 2 to 6 percent slopes	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Beotia-Bearden silt loams, 0 to 3 percent slopes:				
Beotia soil	None to slight	None to slight	None to slight	None to slight.
Bearden soil	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Buse-Forman loams, 9 to 21 percent slopes.	Moderate to severe: excessive slope.	Moderate to severe: excessive slope.	Severe: excessive slope.	Slight to moderate: excessive slope.
Buse-Forman loams, 21 to 40 percent slopes.	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.
Buse-Forman stony complex, 9 to 40 percent slopes.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.
Buse-Sioux complex, 15 to 21 percent slopes.	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.	Moderate: excessive slope.
Buse-Sioux stony complex, 9 to 40 percent slopes.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.
Colvin silty clay loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Dovray silty clay	Severe: wetness; very slow permeability; texture.	Severe: wetness; texture.	Severe: wetness; very slow permeability; texture.	Severe: wetness; texture.
Edgeley loam, 2 to 6 percent slopes	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Edgeley loam, 6 to 9 percent slopes	None to slight	None to slight	Severe: excessive slope.	None to slight.
Edgeley loam, 9 to 15 percent slopes.	Moderate: excessive slope.	Moderate: excessive slope.	Severe: excessive slope.	None to slight.
Embden fine sandy loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Embden fine sandy loam, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Embden-Buse complex, 2 to 9 percent slopes.	None to slight	None to slight	Moderate to severe: excessive slope.	None to slight.
Estelline silt loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Exline-Aberdeen silty clay loams, 0 to 2 percent slopes:				
Exline soil	Severe: wetness; very slow permeability.	Moderate: wetness; texture.	Severe: wetness; very slow permeability.	Moderate: wetness; texture.
Aberdeen soil	Moderate: slow permeability.	Moderate: texture	Moderate: slow permeability; texture.	Moderate: texture.
Fordville loam, 0 to 2 percent slopes	None to slight	None to slight	None to slight	None to slight.
Fordville loam, 2 to 6 percent slopes	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Forman-Aastad loams, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Forman-Aastad loams, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.

TABLE 4.—*Interpretations of the soils for use in recreation*—Continued

Mapping unit	Degree of limitations and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Forman-Aastad loams, 6 to 9 percent slopes.	None to slight	None to slight	Severe: excessive slope.	None to slight.
Forman-Aastad loams, 9 to 15 percent slopes.	Moderate: excessive slope.	Moderate: excessive slope.	Severe: excessive slope.	None to slight.
Forman-Buse loams, 6 to 9 percent slopes, eroded.	None to slight	None to slight	Severe: excessive slope.	None to slight.
Forman-Buse loams, 15 to 25 percent slopes.	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.	Moderate: excessive slope.
Forman-Buse stony complex, 6 to 21 percent slopes.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.	Severe: excessive slope; stoniness.	Severe: stoniness.
Forman-Poinsett complex, 6 to 9 percent slopes.	None to slight	None to slight	Severe: excessive slope.	None to slight.
Forman-Poinsett complex, 9 to 15 percent slopes.	Moderate: excessive slope.	Moderate: excessive slope.	Severe: excessive slope.	None to slight.
Great Bend silt loam, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Great Bend-Beotia silt loams, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Great Bend-Zell silt loams, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Great Bend-Zell silt loams, 6 to 9 percent slopes.	None to slight	None to slight	Severe: excessive slope.	None to slight.
Hamar loamy fine sand	Severe: wetness; texture.	Severe: wetness; texture.	Severe: wetness; texture.	Severe: wetness.
Hamar fine sandy loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes:				
Harmony soil	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Aberdeen soil	Moderate: slow permeability; texture.	Moderate: texture	Moderate: slow permeability; texture.	Moderate: texture.
Hecla loamy fine sand, 0 to 3 percent slopes.	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Hecla-Hamar loamy fine sands, 0 to 3 percent slopes:				
Hecla soil	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Hamar soil	Severe: wetness; texture.	Severe: wetness; texture.	Severe: wetness; texture.	Severe: wetness.
Hecla-Venlo complex, 0 to 6 percent slopes, eroded:				
Hecla soil	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Venlo soil	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Kloten-Buse complex, 15 to 40 percent slopes:				
Kloten soil	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope; moderate permeability; bedrock at a shallow depth.	Moderate to severe: excessive slope.
Buse soil	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.	Moderate to severe: excessive slope.
Kranzburg silt loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Kranzburg silt loam, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Kranzburg silt loam, 6 to 9 percent slopes, eroded.	None to slight	None to slight	Severe: excessive slope.	None to slight.
Kranzburg-Aberdeen silt loams, 0 to 2 percent slopes:				
Kranzburg soil	None to slight	None to slight	None to slight	None to slight.
Aberdeen soil	Moderate: slow permeability.	None to slight	Moderate: slow permeability.	None to slight.
Kranzburg-Aberdeen silt loams, 2 to 6 percent slopes:				
Kranzburg soil	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Aberdeen soil	Moderate: slow permeability.	None to slight	Moderate: slow permeability; excessive slope.	None to slight.

TABLE 4.—*Interpretations of the soils for use in recreation*—Continued

Mapping unit	Degree of limitations and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lamoure silty clay loam	Severe: wetness; subject to flooding; moderate permeability.	Moderate: wetness; subject to flooding.	Severe: wetness; subject to flooding; moderate permeability.	Moderate: wetness; subject to flooding; texture.
Loamy alluvial land	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.
Ludden silty clay	Severe: wetness; very slow permeability; texture.	Severe: wetness; texture.	Severe: wetness; very slow permeability; texture.	Severe: wetness; texture.
Maddock loamy fine sand, 2 to 6 percent slopes.	Moderate: texture	Moderate: texture	Moderate: excessive slope; texture.	Moderate: texture.
Maddock loamy fine sand, 6 to 15 percent slopes.	Moderate: excessive slope; texture.	Moderate: excessive slope; texture.	Severe: excessive slope; texture.	Moderate: texture.
Marsh	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.
Oldham silty clay loam	Severe: wetness; slow permeability.	Severe: wetness	Severe: wetness; slow permeability.	Severe: wetness.
Oldham silty clay loam, saline	Severe: wetness; slow permeability.	Severe: wetness	Severe: wetness; slow permeability.	Severe: wetness.
Parnell silty clay loam	Severe: wetness; subject to flooding; slow permeability.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.; slow permeability.	Severe: wetness; subject to flooding.
Peever clay loam, 0 to 2 percent slopes.	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Peever clay loam, 2 to 6 percent slopes.	Moderate: texture	Moderate: texture	Moderate: excessive slope; texture.	Moderate: texture.
Peever clay loam, 6 to 9 percent slopes.	Moderate: texture	Moderate: texture	Severe: excessive slope.	Moderate: texture.
Peever-Hamerly complex, 0 to 2 percent slopes:				
Peever soil	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Hamerly soil	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Playmoor silty clay loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Poinsett-Forman complex, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Poinsett-Waubay silty clay loams, 0 to 2 percent slopes.	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Poinsett-Waubay silty clay loams, 2 to 6 percent slopes.	Moderate: texture	Moderate: texture	Moderate: excessive slope; texture.	Moderate: texture.
Renshaw-Fordville loams, 0 to 3 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Renshaw-Fordville loams, 3 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Renshaw-Fordville loams, 6 to 9 percent slopes.	None to slight	None to slight	Severe: excessive slope.	None to slight.
Sandy lake beaches	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Serden fine sand, 6 to 21 percent slopes, eroded.	Severe: excessive slope; texture.	Severe: excessive slope; texture.	Severe: excessive slope; texture.	Severe: texture.
Serden-Venlo complex, 0 to 6 percent slopes:				
Serden soil	Severe: texture	Moderate: texture	Severe: texture	Severe: texture.
Venlo soil	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Sieche loam, 6 to 15 percent slopes	Slight to moderate: excessive slope.	Slight to moderate: excessive slope.	Severe: excessive slope.	None to slight.
Sieche loam, 21 to 50 percent slopes	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.	Moderate to severe: excessive slope.
Sinai silty clay, 0 to 3 percent slopes	Severe: slow permeability; texture.	Severe: texture	Severe: slow permeability; texture.	Severe: texture.
Sinai silty clay, 3 to 6 percent slopes	Severe: slow permeability; texture.	Severe: texture	Severe: slow permeability; texture.	Severe: texture.
Sinai silty clay, 6 to 9 percent slopes	Severe: slow permeability; texture.	Severe: texture	Severe: slow permeability; excessive slope; texture.	Severe: texture.
Sioux-Arvilla loams, 15 to 40 percent slopes.	Severe: excessive slope.	Severe: excessive slope.	Severe: excessive slope.	Moderate to severe: excessive slope.
Stirum-Ulen fine sandy loams:				
Stirum soil	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Ulen soil	None to slight	None to slight	Moderate: wetness	Moderate: wetness.
Swenoda fine sandy loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.

TABLE 4.—*Interpretations of the soils for use in recreation*—Continued

Mapping unit	Degree of limitations and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Swenoda fine sandy loam, 2 to 6 percent slopes.	None to slight	None to slight	Moderate: excessive slope.	None to slight.
Swenoda-Larson complex, 0 to 2 cent slopes:				
Swenoda soil	None to slight	None to slight	None to slight	None to slight.
Larson soil	Severe: slow permeability.	None to slight	Severe: slow permeability.	None to slight.
Tonka silt loam	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.
Ulen fine sandy loam	None to slight	None to slight	None to slight	None to slight.
Ulen-Stirum fine sandy loams:				
Ulen soil	None to slight	None to slight	None to slight	None to slight.
Stirum soil	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Vallers loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Wet alluvial land	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.	Severe: wetness; subject to flooding.

3. Locating probable sources of sand, gravel, or roadfill suitable for use as construction material. Among factors that are concerns in selecting locations are depth to water table, presence of stones and boulders, thickness of deposits, shrink-swell potential, susceptibility to frost action, and moisture content.
4. Planning drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soil. Among factors that may be important are permeability and seepage rate, depth to water table, slope, available water capacity, depth to layers of contrasting materials that influence the rate of water movement, and flooding or stream overflow.

The engineering interpretations reported here do not eliminate the need for further investigations at the sites selected for specific engineering works. The soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some terms used by soil scientists may be unfamiliar to engineers, and some words have different meanings in soil science than they have in engineering. Among the terms that have a special meaning in soil science are sand, silt, clay, loam, surface soil, subsoil, and horizon. These and other terms are defined in the glossary at the back of this survey.

Engineering classification of soils

The two systems most commonly used in classifying samples of soil for engineering are the AASHO system (*1*) adopted by the American Association of State Highway Officials, and the Unified system (*11*), used by SCS engineers, the Department of Defense, and others.

The AASHO system is used to classify soils according to those properties that affect use in highway construction. In this system, a soil is placed in one of seven basic groups ranging from A–1 to A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet. The best soils for subgrade, therefore, are classified as A–1, the next best A–2, and so on until class A–7, the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. If soil material is near a classification boundary it is given a symbol showing both classes; for example, A–2 or A–4. Within each group, the relative engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The estimated classification for all soils mapped in the survey area is given in table 5. and the AASHO classification for tested soils, with index numbers in parentheses, is shown in tables 7 and 8.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils, GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, Pt. Soils that are in two classes are given a dual classification; for example, CH or MH. Soils on the borderline between two classes are designated by symbols for both classes, for example, ML–CL.

Estimated soil properties significant to engineering

Table 5 provides estimates of soil properties important to engineering. These estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adjacent areas, and from detailed experience in working with each kind of soil in the county. Some of the terms for which data are shown are explained in the following paragraphs.

In all the soils in Marshall County except Edgeley and Kloten, depth to bedrock is more than 5 feet. In the Edgeley soils shale is at a depth of 30 to 60 inches, and in the Kloten soils it is at a depth of 10 to 20 inches.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the glossary.

Permeability, as used in table 5, relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on soil characteristics that influence porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of these soils are not considered.

Available water capacity is the ability of soils to store water for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the glossary.

Salinity of the soil is based on the electrical conductivity of the saturated soil extract, as expressed in millimhos per centimeter at 25° C. The salinity rating and salinity as millimhos per centimeter are listed below.

Salinity rating	*Salinity as millimhos per cm*
None	Less than 2.0
Low	2.0 to 4.0
Moderate	4.0 to 8.0
High	8.0 to 16.0
Very high	More than 16.0

Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to other materials.

Shrink-swell potential is the relative change in volume to be expected of the soil material with changes in moisture content. The shrinking and swelling of soils causes much damage to foundations of buildings, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures constructed in, on, or with material having this rating.

Corrosivity, as used in table 5, indicates the potential danger to uncoated steel or concrete structures through chemical action that dissolves or weakens the structural material. Structural materials may corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations of uncoated steel that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon.

Interpretations of engineering properties of the soils

Table 6 provides selected information useful to engineers and others who plan to use soil material in constructing highways, farm facilities, buildings, and sewage-disposal systems. Detrimental or undesirable features are emphasized, but very important desirable features also may be listed. The ratings and other interpretations in this table are based on estimated engineering properties of the soils shown in table 5; available test data, including those provided in tables 7 and 8; and on field experience. Although the information applies only to soil depths indicated in table 5, it is reasonably reliable to depths of about 5 or 6 feet.

The degree of limitation and principal reasons for assigning moderate or severe limitations are given in table 6.

Soil properties that affect septic-tank absorption fields are mainly permeability, location of the water table, susceptibility to flooding, and slope.

Sewage lagoons are influenced chiefly by such soil features as permeability, location of the water table, and slope.

Shallow excavations require digging and trenching to a depth of less than 6 feet. These excavations are made for a variety of purposes. Examples are basements, ditches, graves, underground cables, pipelines, and sewers.

Properties that affect the rating of a soil for dwellings with basements are based chiefly on those characteristics that affect foundations. Among the soil properties considered are slope, susceptibility to flooding, seasonal wetness, and depth to bedrock.

Sanitary landfills are methods for disposing of solid waste on or in the soil by spreading the waste in thin layers, compacting it to the smallest practical volume, and covering it with soil throughout the disposal period.

Local roads and streets, for which soil ratings are given in table 6, have some kind of all-weather surfacing, commonly asphalt or concrete. They are expected to carry automobile traffic all year, but not fast-moving heavy trucks.

The suitability of the soils as a source of road fill, sand and gravel, and topsoil is also given in table 6. A rating of *good*, *fair*, *poor*, or *unsuited* and the principal reasons for the rating are given for each soil.

Road fill is soil material used in embankments to support the subbase and base course or surface course. The ratings indicate performance of soil material moved from borrow areas for these purposes.

Ratings of the suitability of the soils as a source of sand and gravel are based on the probability that delineated areas of the soil contain deposits of sand and gravel or sand alone and provide guidance about where to look for it. The ratings do not indicate the size of the deposit.

Topsoil is soil material used for spreading over barren surfaces, lawns, and gardens where adapted vegetation is to be established and maintained.

Soil features affecting pond reservoir areas; dikes, levees, and other embankments; drainage; irrigation; terraces and diversions; and grassed waterways are also given in table 6.

Pond reservoir areas are affected mainly by seepage or loss of water. Among the soil features that influence such seepage are permeability and depth to permeable material.

Factors considered in selecting soils for dikes, levees, and other embankments are those features and qualities of disturbed soils that affect the performance of soils if used in constructing earthfills. The features, both in the subsoil and the substratum, are evaluated where the soil has significant thickness for use as borrow material.

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series in the first column of this table. The

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
Aastad: AaA	>5	0–15	Loam	ML or CL	A–6 or A–7
		15–28	Clay loam	ML–CL or CL	A–6 or A–7
		28–60	Clay loam	ML or CL	A–6 or A–7
*Aberdeen: AbA	4–10	0–11	Silty clay loam	ML–CL or CL	A–6 or A–7
For Exline part, see Exline series.		11–22	Silty clay	MH or CH	A–7
		22–60	Silty clay loam	CL or CH	A–6 or A–7
Arveson: Ar	0–3	0–14	Fine sandy loam	SM	A–4
		14–26	Fine sandy loam	SM	A–4
		26–60	Loamy fine sand	SM	A–2 or A–4
*Arvilla: AsE	>5	0–9	Loam	ML	A–4
For Sioux part, see Sioux series.		9–17	Coarse sandy loam	SM	A–2 or A–4
		17–60	Sand and gravel	GW, GM, SW, or SM	A–1 or A–2
*Bearden: Ba, BdA	3–5	0–9	Silt loam	ML–CL	A–6 or A–7
For Tonka part of BdA, see Tonka series.		9–32	Silt loam	ML–CL or CL	A–6 or A–7
		32–60	Silt loam	ML or CL	A–6 or A–7
*Benoit: Be	<3	0–7	Loam	ML or CL	A–4 or A–6
For Divide part, see Divide series.		7–22	Loam	ML or CL	A–4 or A–6
		22–60	Sand and gravel	SM, SC, GM, or GC	A–1 or A–2
*Beotia: BfA, BfB, BhA	>5	0–25	Silt loam	ML–CL	A–4 or A–6
For Bearden part of BhA, see Bearden series.		25–60	Silt loam	ML–CL or CL	A–4 or A–6
*Buse: BkE, BkF, BmF, BsE, BtE	>5	0–8	Loam	ML–CL	A–4 or A–6
For Forman part of BkE, BkF, and BmF, see Forman series; for Sioux part of BsE and BtE, see Sioux series.		8–21	Clay loam	ML–CL or CL	A–4 or A–6
		21–60	Clay loam	ML–CL or CL	A–4 or A–6
Colvin: Co	1–5	0–10	Silty clay loam	ML–CL	A–6 or A–7
		10–60	Silty clay loam	ML–CL or CL	A–6 or A–7
Divide	3–5	0–10	Loam	ML or CL	A–4 or A–6
Mapped only with Benoit soils.		10–30	Loam	ML or CL	A–4 or A–6
		30–60	Sand and gravel	SM, SC, GM, or GC	A–1 or A–2
Dovray: Do	>4	0–60	Silty clay	CH	A–7
Edgeley: EdB, EdC, EdD	>5	0–15	Loam and clay loam	ML or CL	A–4 or A–6
		15–27	Clay loam	CL	A–6 or A–7
		27–41	Shaly clay loam	CL	A–6 or A–7
		41–60	Shale.		
*Embden: EmA, EmB, EnC	>5	0–34	Fine sandy loam	SM or SC	A–4
For Buse part of EnC, see Buse series.		34–40	Loamy fine sand	SM	A–2
		40–60	Fine sandy loam	SM or SC	A–4

See footnote at end of table.

significant to engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*	*Mmhos./cm. at 25° C.*			
100	95–100	80–95	60–75	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3	None	Low	Moderate	Low.
100	95–100	85–100	65–80	0. 6–1. 2	0. 19–0. 22	7. 4–7. 8	None	Moderate to high.	Moderate	Low.
100	95–100	85–100	60–80	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	None	Moderate to high.	Moderate	Moderate.
100	100	90–100	70–95	0. 6–1. 2	0 19–0. 22	6. 6–7. 8	None	Moderate	Moderate	Low.
100	100	95–100	85–95	0. 06–0. 2	0. 13–0. 18	7. 9–8. 6	Low	High	High	Moderate.
100	100	90–100	70–95	0. 06–0. 2	0. 11–0. 14	8. 5–9. 0	Moderate	Moderate to high.	High	Moderate to high.
100	100	70–85	40–50	2. 0–6. 0	0. 14–0. 17	7. 9–8. 4	None	Low	High	Low.
100	100	70–85	40–50	2. 0–6. 0	0. 12–0. 15	7. 9–9. 0	None	Low	High	Low.
100	100	65–85	20–45	2. 0–6. 0	0. 08–0. 10	7. 9–9. 0	None	Low	High	Low.
100	100	85–95	60–75	1. 2–2. 0	0. 18–0. 20	6. 6–7. 3	None	Low	Low	Low.
100	100	60–70	30–40	2. 0–6. 0	0. 11–0. 15	6. 6–7. 3	None	Low	Low	Low.
25–45	15–50	10–40	0–25	6. 0–20. 0	0. 03–0. 06	7. 4–7. 8	None	Low	Low	Low.
100	100	90–100	85–95	0. 6–1. 2	0. 19–0. 22	7. 9–8. 4	None	Low to moderate.	High	Low.
100	100	90–100	85–95	0. 06–0. 2	0. 14–0. 17	7. 9–8. 4	None	Low to moderate.	High	Low.
100	100	90–100	85–95	0. 06–0. 2	0. 17–0. 20	8. 4–9. 0	None	Low to moderate.	High	Low.
100	100	85–95	60–80	1. 2–2. 0	0. 18–0. 20	7. 4–8. 4	None	Low	High	Low.
100	100	85–95	60–80	1. 2–2. 0	0. 13–0. 15	7. 9–8. 4	None	Low	High	Low.
25–75	15–50	10–40	5–25	6. 0–10. 0	0. 03–0. 06	7. 9 8. 4	None	Low	High	Low.
100	100	90–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3	None	Low to moderate.	Low	Low.
100	100	90–100	85–98	0. 6–1. 2	0. 17–0. 20	7. 9–8. 4	None	Moderate	Low	Low.
100	95–100	85–95	50–80	1. 2–2. 0	0. 18–0. 20	7. 4–7. 8	None	Low to moderate.	Low	Low.
100	95–100	85–100	60–80	0. 6–1. 2	0. 17–0. 20	7. 9–8. 4	None	Moderate	Moderate	Low.
100	95–100	85–100	60–80	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	None	Moderate	Moderate	Moderate.
100	100	90–100	85–95	0. 2–0. 6	0. 19–0. 22	7. 4–8. 4	Low	Moderate	High	Low.
100	100	90–100	85–95	0. 2–0. 6	0. 14–0. 17	7. 9–9. 0	Low to moderate.	Moderate	High	Moderate.
100	100	85–95	60–75	2. 0–6. 0	0. 18–0. 20	7. 4–8. 4	None	Low to moderate.	Low	Low.
100	100	85–95	60–75	2. 0–6. 0	0. 16–0. 18	7. 9–9. 0	None	Low to moderate.	High	Low.
25–75	15–50	10–40	5–25	6. 0–10. 0	0. 03–0. 06	7. 9–9. 0	None	Low	High	Low.
100	96–100	90–100	75–100	<0. 06	0. 10–0. 14	7. 4–8. 4	None	High	High	Low to moderate.
100	100	85–95	60–80	0. 6–2. 0	0. 18–0. 20	6. 6–7. 8	None	Low	Low	Low.
100	100	90–100	70–80	0. 6–1. 2	0. 17–0. 20	7. 4–7. 8	None	Moderate	Moderate	Low.
100	100	90–100	70–80	0. 6–1. 2	0. 17–0. 20	7. 9–8. 4	None	Moderate	Moderate	Low.
100	100	70–98	40–50	2. 0–6. 0	0. 14–0. 17	6. 6–7. 8	None	Low	Low	Low.
100	100	50–75	15–30	2. 0–6. 0	0. 08–0. 10	7. 4–7. 8	None	Low	Low	Low.
100	100	70–95	35–50	2. 0–6. 0	0. 12–0. 15	7. 4–7. 8	None	Low	Low	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
Estelline: EsA	>5	0–16	Silt loam	ML–CL	A–6
		16–30	Silt loam	ML–CL	A–6
		30–60	Sand and gravel	SW, SM, GW, or GM	A–1 or A–2
*Exline: ExA	4–8	0–4	Silt loam	ML or CL	A–6
For Aberdeen part, see Aberdeen series.		4–19	Silty clay	MH or MH–CH	A–7
		19–60	Silty clay	MH or CH	A–7
Fordville: FoA, FoB	>5	0–17	Loam	ML or ML–CL	A–4 or A–5
		17–25	Loam	ML, CL, or SM–SC	A–4 or A–6
		25–60	Sand and gravel	SW, SM, GW, or GM	A–1 or A–2
*Forman: FrA, FrB, FrC, FrD, FsC2, FsE, FtD, FxC, FxD. For Aastad part of FrA, FrB, FrC, and FrD, see Aastad series; for Buse part of FsC2, FsE, and FtD, see Buse series; for Poinsett part of FxC and FxD, see Poinsett series.	>5	0–13	Loam	ML or CL	A–6 or A–7
		13–20	Clay loam	ML–CL or CL	A–6 or A–7
		20–60	Clay loam	CL	A–6 or A–7
*Great Bend: GbB, GdA, GeB, GeC	>5	0–8	Silt loam	ML–CL or CL	A–4 or A–6
For Beotia part of GdA, see Beotia series; for Zell part of GeB and GeC, see Zell series.		8–60	Silt loam	ML–CL or CL	A–4 or A–6
Hamar: Ha, Hd	1–3	0–23	Loamy fine sand	SM	A–2
		23–60	Fine sand	SM	A–2
Hamerly	3–4	0–9	Loam	ML or CL	A–4 or A–6
Mapped only with Peever soils.		9–36	Clay loam	ML or CL	A–6 or A–7
		36–60	Clay loam	ML or CL	A–6 or A–7
*Harmony: HeA	>4	0–8	Silty clay loam	MH or CL	A–6 or A–7
For Aberdeen part, see Aberdeen series.		8–25	Silty clay	MH or CH	A–7
		25–60	Silty clay loam	ML–CL or CL	A–6 or A–7
*Hecla: HfA, HhA, HvB2	4–10	0–35	Loamy fine sand	SM	A–2 or A–4
For Hamar part of HhA, see Hamar series; for Venlo part of HvB2, see Venlo series.		35–60	Fine sand	SM or ML–CL	A–2 or A–4
*Kloten: KbE	>5	0–7	Silt loam	ML or CL	A–6
For Buse part, see Buse series.		7–15	Silty clay loam	CL or CH	A–7 or A–6
		15–60	Bedded shale.		
*Kranzburg: KnA, KnB, KnC2, KrA, KrB	>5	0–14	Silt loam	ML or CL	A–6
For Aberdeen part of KrA and KrB, see Aberdeen series.		14–26	Silt loam	ML or CL	A–6
		26–60	Clay loam	CL	A–6 or A–7
Lamoure: La	2–5	0–27	Silty clay loam	ML–CL or MH	A–6 or A–7
		27–60	Silty clay loam	ML–CL or MH	A–6 or A–7
Larson	>5	0–8	Loam	ML or CL	A–4
Mapped only with Swenoda soils.		8–13	Clay loam	CL or SC	A–6 or A–7
		13–29	Clay loam	CL or SC	A–6 or A–7
		29–60	Silt loam	ML or SM	A–4 or A–6

See footnote at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*	*Mmhos./cm. at 25° C.*			
100	100	90–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3	None	Moderate	Low	Low.
100	100	90–100	85–95	0. 6–2. 0	0. 17–0. 20	6. 6–8. 4	None	Moderate	Low	Low.
25–95	15–75	10–60	5–45	10. 0–20. 0	0. 03–0. 06	7. 9–8. 4	None	Low	Low	Low.
100	100	90–100	75–100	0. 6–1. 2	0. 19–0. 22	6. 6–7. 3	None	Low	High	Low.
100	100	98–100	90–100	<0. 06	0. 10–0. 15	7. 9–9. 0	Moderate	High	High	Moderate.
100	100	95–100	90–100	<0. 06	0. 08–0. 13	8. 5–9. 0	Moderate	High	High	Moderate to high.
100	86–100	80–95	55–70	1. 2–2. 0	0. 18–0. 20	6. 6–7. 3	None	Low	Low	Low.
100	86–100	65–95	45–70	1. 2–2. 0	0. 16–0. 18	6. 6–7. 3	None	Low	Low	Low.
25–75	15–65	15–40	5–25	6. 0–20. 0	0. 03–0. 06	7. 4–8. 4	None	Low	Low	Low.
100	86–100	80–100	60–80	1. 2–2. 0	0. 18–0. 20	6. 6–7. 8	None	Moderate	Low	Low.
100	86–100	80–100	65–85	0. 6–1. 2	0. 17–0. 20	7. 4–7. 8	None	Moderate to high.	Moderate	Low.
100	65–100	70–100	60–85	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	None	Moderate	Moderate	Moderate.
100	100	90–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3	None	Low to moderate.	Low	Low.
100	100	90–100	85–95	0. 6–2. 0	0. 17–0. 20	6. 6–8. 4	None	Low to moderate.	Low	Low.
100	100	50–75	15–30	2. 0–10. 0	0. 10–0. 12	7. 4–7. 8	None	Low	Low	Low.
100	100	65–80	20–35	6. 0–10. 0	0. 08–0. 10	7. 4–7. 8	None	Low	High	Low.
100	90–100	85–95	50–70	1. 2–2. 0	0. 18–0. 20	7. 9–8. 4	None	Moderate	Moderate	Low.
100	90–100	85–100	55–75	1. 2–2. 0	0. 14–0. 17	8. 5–9. 0	None	Moderate	High	Low.
100	90–100	85–100	55–75	0. 2–0. 6	0. 17–0. 20	8. 5–9. 0	None	Moderate	High	Moderate.
100	100	95–100	85–100	0. 6–1. 2	0. 19–0. 22	7. 9–8. 4	None	Moderate	High	Low.
100	100	95–100	90–100	0. 6–1. 2	0. 13–0. 18	7. 9–8. 4	None	High	High	Low.
100	100	90–100	70–100	0. 6–1. 2	0. 17–0. 20	7. 9–9. 0	Low	Moderate	High	Moderate.
100	100	50–100	15–40	2. 0–10. 0	0. 10–0. 12	6. 6–7. 3	None	Low	Low	Low.
100	100	65–100	20–60	6. 0–10. 0	0. 06–0. 08	6. 6–7. 3	None	Low	Low	Low.
100	100	90–100	70–90	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3	None	Moderate	Low	Low.
100	100	95–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3	None	Moderate to high.	Moderate	Low.
100	95–100	90–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3	None	Moderate	Low	Low.
100	95–100	90–100	85–95	0. 6–2. 0	0. 17–0. 20	6. 6–7. 8	None	Moderate	Low	Low.
100	95–100	90–100	70–95	0. 2–0. 6	0. 17–0. 20	8. 5–9. 0	None	Moderate to high.	Moderate	Moderate.
100	95–100	85–100	80–95	0. 6–1. 2	0. 19–0. 22	7. 9–8. 4	None	Moderate to high.	High	Low.
100	95–100	85–100	80–95	0. 6–1. 2	0. 17–0. 20	7. 9–8. 4	Low	Moderate to high.	High	Low.
100	100	85–95	60–75	0. 6–1. 2	0. 18–0. 20	6. 6–7. 3	None	Low	Low	Low.
100	100	85–100	45–80	0. 06–0. 2	0. 19–0. 22	7. 9–8. 4	None	Moderate	High	Moderate.
100	100	85–100	45–80	0. 06–0. 2	0. 14–0. 17	7. 9–8. 4	Low	Moderate	High	Moderate.
100	100	85–100	45–90	0. 06–0. 2	0. 17–0. 20	7. 9–8. 4	Low	Low to moderate.	High	Moderate.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
Loamy alluvial land: Lo. Too variable to be rated.					
Ludden: Lu	2–3	0–60	Clay	CH	A–7
Maddock: MaB, MaD	>5	0–15	Loamy fine sand	SM	A–2 or A–4
		15–60	Fine sand	SM	A–2
Marsh: Mr. Too variable to be rated.					
Oldham: Od, Oh	2–4	0–30	Silty clay loam	CL or CH	A–7
		30–60	Silt loam	ML or CL	A–6 or A–7
Parnell: Pa	0–4	0–13	Silty clay loam	CL or CH	A–7
		13–29	Silty clay	CH	A–7
		29–35	Silty clay	CH	A–7
		35–60	Silty clay loam	CL or CH	A–7
*Peever: PeA, PeB, PeC, PhA For Hamerly part of PhA, see Hamerly series.	>5	0–14	Clay loam	ML or CL	A–6 or A–7
		14–60	Clay loam	CL or CH	A–6 or A–7
Playmoor:[1] Pm	1–3	0–37	Silty clay loam	ML–CL or MH	A–6 or A–7
		37–60	Silty clay loam	ML–CL or MH	A–6 or A–7
*Poinsett: PoB, PwA, PwB For Forman part of PoB, see Forman series; for Waubay part of PwA and PwB, see Waubay series.	>5	0–13	Silt loam	ML or CL	A–6 or A–7
		13–60	Silty clay loam	ML–CL or CL	A–6 or A–7
*Renshaw: RfA, RfB, RfC For Fordville part of RfA, RfB, and RfC, see Fordville series.	>5	0–17	Loam	ML	A–4
		17–60	Sand and gravel	SM, GC, GP, or GW.	A–1 or A–2
Sandy lake beaches: Sa. Too variable to be rated.					
*Serden: SdD2, SeB For Venlo part of SeB, see Venlo series.	>5	0–60	Fine sand	SM	A–2
Sieche: ShD, ShF	>5	0–15	Loam	ML or CL	A–6
		15–24	Clay loam	CL or CH	A–6 or A–7
		24–32	Clay	CL or CH	A–7
		32–60	Clay loam	CL or CH	A–6 or A–7
Sinai: SkA, SkB, SkC	>5	0–19	Silty clay	MH or CH	A–7
		19–50	Silty clay	MH or CH	A–7
		50–60	Silty clay loam	MH–CH or CL	A–7
*Sioux: SmE For Arvilla part, see Arvilla series.	>5	0–8	Loam	ML	A–4
		8–60	Sand and gravel	SM, GM, GP, GW, or SM–SC.	A–1 or A–2

See footnote at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*	*Mmhos./cm. at 25° C.*			
100	100	90–100	75–95	<0. 06	0. 10–0. 14	7. 4–9. 0	Low	High	High	Moderate.
100	100	70–85	15–40	6. 0–10. 0	0. 10–0. 12	6. 6–7. 3	None	Low	Low	Low.
100	100	65–80	15–35	6. 0–10. 0	0. 06–0. 08	6. 6–7. 3	None	Low	Low	Low.
100	100	95–100	85–95	0. 06–0. 2	0. 19–0. 22	7. 4–8. 4	None	Moderate to high.	High	Low.
100	100	90–100	70–95	0. 06–0. 2	0. 17–0. 20	7. 9–8. 4	Low	Moderate to high.	High	Moderate.
100	98–100	95–100	75–95	0. 06–0. 2	0. 16–0. 19	6. 6–7. 3	None	High	High	Low.
100	100	95–100	90–100	0. 06–0. 2	0. 13–0. 18	7. 4–7. 8	None	High	High	Low.
100	100	95–100	90–100	0. 06–0. 2	0. 11–0. 16	7. 9–8. 4	None	High	High	Low.
100	97–100	90–100	85–95	0. 06–0. 2	0. 14–0. 17	7. 9–8. 4	None	High	High	Low.
100	98–100	90–100	70–95	0. 2–0. 6	0. 16–0. 19	6. 6–7. 3	None	Moderate	Moderate	Low.
100	98–100	90–100	70–95	0. 06–0. 2	0. 14–0. 17	6. 6–8. 4	None	Moderate to high.	Moderate	Moderate.
100	100	90–100	70–95	0. 2–0. 6	0. 19–0. 22	7. 4–8. 4	Low to moderate.	Moderate to high.	High	Moderate.
100	100	90–100	70–95	0. 2–0. 6	0. 14–0. 17	7. 9–8. 4	Low to moderate.	Moderate to high.	High	Moderate.
100	100	90–100	85–95	1. 2–2. 0	0. 19–0. 22	6. 6–7. 3	None	Low to moderate.	Low	Low.
100	90–100	85–90	85–95	0. 6–2. 0	0. 17–0. 20	6. 6–8. 4	None	Moderate	Moderate	Low.
100	100	85–95	60–75	2. 0–6. 0	0. 18–0. 20	6. 6–7. 3	None	Low	Low	Low.
25–95	15–85	20–60	0–25	6. 0–20. 0	0. 03–0. 06	7. 4–7. 8	None	Low	Low	Low.
100	100	50–80	15–35	6. 0–20. 0	0. 06–0. 08	6. 6–7. 3	None	Low	Low	Low.
100	100	85–95	60–75	1. 2–2. 0	0. 18–0. 20	6. 1–7. 3	None	Low	Low	Low.
100	100	90–100	70–80	0. 6–1. 2	0. 19–0. 22	6. 1–7. 3	None	Moderate to high.	Moderate	Low.
100	100	90–100	75–95	0. 6–1. 2	0. 11–0. 16	6. 6–7. 3	None	High	High	Low.
100	100	90–100	70–85	0. 6–1. 2	0. 14–0. 17	7. 9–8. 4	None	Moderate to high.	Moderate	Moderate.
100	100	90–100	80–95	0. 06–0. 2	0. 13–0. 18	6. 6–7. 8	None	High	High	Low.
100	100	90–100	90–95	0. 06–0. 2	0. 11–0. 16	7. 9–9. 0	None	High	High	Low.
100	100	90–100	85–98	0. 06–0. 2	0. 14–0. 17	8. 5–9. 0	None	High	High	Low.
100	100	85–95	60–75	0. 6–1. 2	0. 18–0. 20	7. 4–8. 4	None	Low	Low	Low.
25–75	15–50	10–40	0–25	6. 0–20. 0	0. 03–0. 06	7. 9–8. 4	None	Low	Low	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
*Stirum: Su	0–3	0–8	Fine sandy loam	ML or SM	A–4
		8–15	Fine sandy loam	ML or SM	A–4
For Ulen part, see Ulen series.		15–32	Fine sandy loam	ML or SM	A–4
		32–60	Loamy fine sand	SM	A–2 or A–4
*Swenoda: SwA, SwB, SxA	>5	0–29	Fine sandy loam	SM or ML	A–4
		29–60	Silt loam	ML or CL	A–4 or A–6
For Larson part of SxA, see Larson series.					
Tonka: To	<4	0–18	Silt loam	ML or CL	A–6
		18–40	Silty clay	CL or CH	A–7
		40–60	Silty clay loam	CL or CH	A–6 or A–7
*Ulen: Uf, Us	3–10	0–10	Fine sandy loam	SM	A–4
		10–24	Fine sandy loam	SM	A–4
For Stirum part of Us, see Stirum series.		24–60	Loamy fine sand	SM	A–2
Vallers: Va	2–4	0–8	Loam	ML–CL or CL	A–6
		8–18	Clay loam	CL	A–6 or A–7
		18–60	Clay loam	CL	A–6 or A–7
Venlo	0–3	0–10	Loamy fine sand	SM	A–2 or A–4
		10–60	Fine sand	SM	A–2
Mapped only in complex with Hecla and Serden soils.					
Waubay	>5	0–18	Silty clay loam	ML–CL or CL	A–6 or A–7
		18–42	Silty clay loam	ML–CL or CL	A–6 or A–7
Mapped only with Poinsett soils.		42–60	Clay loam	CL	A–6 or A–7
Wet alluvial land: Wa.					
Too variable to be rated.					
Zell	>5	0–6	Silt loam	ML or ML–CL	A–4
		6–60	Silt loam	ML or ML–CL	A–4
Mapped only with Great Bend soils.					

[1] Stratified sand and gravel is below a depth of 40 inches in some profiles.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*	*Mmhos./cm. at 25° C.*			
100	100	70–95	40–75	0. 6–1. 2	0. 14–0. 17	7. 9–8. 4	None	Low	Low	Low.
100	100	70–95	40–75	0. 2–0. 6	0. 11–0. 14	8. 5–9. 0	Low	Low	High	Low to moderate.
100	100	70–95	40–55	1. 2–6. 0	0. 09–0. 12	8. 5–9. 0	Low	Low	High	Low to moderate.
100	100	50–75	15–50	2. 0–6. 0	0. 08–0. 10	8. 5–9. 0	Low	Low	High	Low to moderate.
100	90–100	70–85	40–55	2. 0–6. 0	0. 14–0. 17	6. 6–7. 8	None	Low	Low	Low.
100	100	75–100	70–95	0. 6–2. 0	0. 17–0. 20	7. 4–8. 4	None	Low to moderate.	Moderate	Low.
100	100	90–100	70–95	1. 2–2. 0	0. 19–0. 22	6. 1–6. 5	None	Low	Low	Low.
100	100	90–100	85–95	0. 06–0. 2	0. 11–0. 16	6. 6–7. 3	None	High	High	Low.
100	100	90–100	75–95	0. 2–0. 6	0. 17–0. 20	7. 4–7. 8	None	Moderate to high.	High	Low.
100	100	70–85	25–50	2. 0–6. 0	0. 14–0. 17	7. 4–7. 8	None	Low	Low	Low.
100	100	70–85	25–50	6. 0–10. 0	0. 12–0. 15	7. 9–8. 4	None	Low	Moderate	Low.
100	100	50–75	15–30	6. 0–10. 0	0. 08–0. 10	7. 4–8. 4	None	Low	Moderate	Low.
100	95–100	85–95	60–75	0. 2–0. 6	0. 18–0. 20	7. 4–7. 8	None	Low to moderate.	High	Low.
100	95–100	85–100	60–85	0. 2–0. 6	0. 14–0. 17	7. 9–8. 4	Low	Moderate	High	Low.
100	90–100	85–100	60–85	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	Low	Moderate	High	Moderate.
100	100	65–85	15–45	6. 0–10. 0	0. 10–0. 12	6. 6–7. 3	None	Low	High	Low.
100	100	65–80	15–35	6. 0–10. 0	0. 06–0. 08	6. 6–7. 8	None	Low	High	Low.
100	100	90–100	85–95	0. 6–1. 2	0. 19–0. 22	6. 6–7. 8	None	Moderate to high.	High	Low.
100	100	95–100	85–95	0. 6–1. 2	0. 17–0. 20	7. 4–8. 4	None	Moderate to high.	High	Low.
100	100	90–100	60–80	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	None	Moderate to high.	High	Low.
100	100	90–100	85–95	1. 2–2. 0	0. 19–0. 22	7. 4–7. 8	None	Low	Low	Low.
100	100	90–100	85–95	1. 2–2. 0	0. 14–0. 17	7. 9–8. 4	None	Low	Low	Low.

TABLE 6.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfills [1]	Local roads and streets	Road fill
Aastad: AaA	Severe: moderately slow permeability in substratum.	Slight	Moderate: moderately well drained.	Moderate to severe: moderate to high shrink-swell potential.	Severe: run-in water from adjacent slopes.	Severe: moderate to high shrink-swell potential.	Poor: AASHO Group Index more than 8; moderate to high shrink-swell potential.
*Aberdeen: AbA. For Exline part, see Exline series.	Severe: slow permeability.	Moderate: moderately high water table.	Severe: moderately well drained to somewhat poorly drained; silty clay.	Severe: high shrink-swell potential.	Severe: silty clay.	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
Arveson: Ar	Severe: high water table.	Severe: high water table; moderately rapid permeability.	Severe: very poorly drained.	Severe: very poorly drained.	Severe: high water table; very poorly drained.	Severe: very poorly drained.	Poor: very poorly drained.
*Arvilla: AsE. For Sioux part, see Sioux series.	Moderate where slopes are 9 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: slopes are greater than 9 percent.	Severe: sand and gravel below a depth of 14 to 30 inches.	Moderate where slopes are 9 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: rapid permeability.	Moderate where slopes are 9 to 15 percent. Severe where slopes are greater than 15 percent.	Good where slopes are less than 15 percent. Fair where slopes are greater than 15 percent.
*Bearden: Ba, BdA. For Tonka part of BdA see Tonka series.	Severe: slow permeability; seasonal high water table.	Moderate to severe: seasonal high water table at a depth of 3 to 5 feet.	Moderate to severe: moderately well drained to somewhat poorly drained; seasonal high water table.	Severe: moderately well drained to somewhat poorly drained: high susceptibility to frost heave.	Severe: seasonal high water table.	Severe: high susceptibility to frost heave.	Poor: moderate shrink-swell potential; high susceptibility to frost heave.
*Benoit: Be. For Divide part, see Divide series.	Severe: high water table.	Severe: high water table; moderately rapid to rapid permeability; hazard of occasional flooding.	Severe: high water table; hazard of occasional flooding.	Severe: poorly drained to very poorly drained; hazard of occasional flooding.	Severe: high water table; hazard of occasional flooding; moderately rapid to rapid permeability.	Severe: poorly drained to very poorly drained.	Poor: poorly drained to very poorly drained.
*Beotia: BfA, BfB BhA. For Bearden part of BhA see Bearden series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Slight	Severe: moderate shrink-swell potential; AASHO Group Index more than 8.	Poor: AASHO Group Index more than 8; moderate shrink-swell potential.
*Buse: BkE, BkF, BmF, BsE, BtE. For Forman part of BkE, BkF, and BmF, see Forman series; for Sioux part of BsE and BtE, see Sioux series.	Severe: moderately slow permeability in substratum.	Moderate where slopes are less than 6 percent. Severe where slopes are greater than 6 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are greater than 15 percent; moderate shrink-swell potential.	Moderate where slopes are less than 25 percent. Severe where slopes are greater than 25 percent; clay loam.	Moderate where slopes are less than 15 percent. Severe where slopes are greater than 15 percent; moderate shrink-swell potential.	Fair where slopes are less than 25 percent. Poor where slopes are greater than 25 percent; moderate shrink-swell potential.

See footnotes at end of table.

engineering properties of the soils

have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series in the first column of this table]

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Good	All features favorable.	Fair to poor stability and compaction characteristics; low permeability when compacted.	Concave swales and toe slopes receive run-in water; moderately slow permeability in substratum.	Moderate water intake rate; high available water capacity.	Fair to poor stability; moderate permeability.	All features favorable.
Unsuited: no sand or gravel.	Fair to a depth of 11 inches, poor below; silty clay loam in upper 11 inches, silty clay below.	Slow permeability; seasonal high water table.	Fair to poor stability and compaction characteristics; medium to very high compressibility.	Slow permeability; seasonal high water table at a depth of 4 to 10 feet.	Slow water intake rate; subject to salt accumulation in substratum.	Slow permeability; slopes are less than 2 percent; generally not applicable.	Fair to poor stability; silty clay loam and silty clay.
Poor: more than 15 percent fines; high water table; no gravel.	Poor: very poorly drained.	High water table; moderately rapid permeability.	Good stability; fair to good compaction characteristics; slight compressibility; poor resistance to piping.	Moderately rapid permeability; high water table.	High water table; generally not applicable.	Nearly level; high water table.	Generally not applicable.
Good to poor: 0 to 25 percent fines.	Fair where slopes are less than 15 percent. Poor where slopes are greater than 15 percent.	Rapid permeability in the substratum.	Rapid permeability; fair to poor stability and compaction characteristics; poor to good resistance to piping.	Excessively drained; rapid permeability.	Slopes are greater than 9 percent; generally not applicable.	Slopes of greater than 9 percent are irregular; sand and gravel below a depth of 14 to 30 inches.	Hazard of erosion; low available water capacity; sand and gravel below a depth of 14 to 30 inches.
Unsuited: no sand or gravel.	Good	Slow permeability in substratum; seasonal high water table.	Fair to poor stability and compaction characteristics; medium to high compressibility; moderate to low permeability when compacted.	Slow permeability in substratum; seasonal high water table.	Moderate water intake rate; high available water capacity; seasonal high water table.	Slow permeability in substratum; slopes generally 2 percent or less; seasonal high water table.	Moderately well drained to somewhat poorly drained; slopes generally 2 percent or less.
Poor: high water table; more than 15 percent fines in places.	Poor: poorly drained to very poorly drained.	High water table; rapid permeability in sand and gravel substratum.	Fair to poor stability and compaction characteristics; medium to low shear strength; slight compressibility.	Low wet areas; moderately rapid to rapid permeability; high water table.	High water table; generally not applicable.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Good	Moderate permeability.	Good to poor stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Moderate permeability; well drained.	Moderate water intake rate; high available water capacity.	All features favorable.	Slight hazard of erosion; high available water capacity.
Unsuited: no sand or gravel.	Fair where slopes are less than 15 percent. Poor where slopes are greater than 15 percent; clay loam below a depth of 8 inches.	Moderately slow permeability in substratum; steep.	Low permeability when compacted; medium compressibility; good resistance to piping; medium to low shear strength; good stability.	Slopes of 6 to 40 percent; moderately slow permeability in substratum.	Slopes of 6 to 40 percent; generally not applicable.	Slopes are complex and generally steep; moderately slow permeability in substratum.	Hazard of erosion; difficult to vegetate, slopes of 6 to 40 percent.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfills [1]	Local roads and streets	Road fill
Colvin: Co	Severe: seasonal high water table; hazard of flooding.	Severe: seasonal high water table; hazard of flooding.	Severe: poorly drained; hazard of flooding; seasonal high water table.	Severe: poorly drained; hazard of flooding.	Severe: poorly drained; seasonal high water table; hazard of flooding.	Severe: poorly drained; hazard of flooding; high susceptibility to frost heave.	Poor: poorly drained.
Divide Mapped only with Benoit soils.	Severe: seasonal high water table. [2]	Severe: seasonal high water table; moderately rapid to rapid permeability.	Severe: moderately well drained to somewhat poorly drained; gravel below a depth of 20 to 36 inches; seasonal high water table at a depth of 3 to 5 feet.	Moderate to severe: moderately well drained to somewhat poorly drained.	Severe: seasonal high water table; moderately rapid to rapid permeability.	Moderate: moderately well drained to somewhat poorly drained; moderate shrink-swell potential above sand and gravel.	Fair: moderately well drained to somewhat poorly drained.
Dovray: Do	Severe: very slow permeability.	Slight	Severe: poorly drained; silty clay.	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; silty clay.	Severe: poorly drained; high shrink-swell potential.	Poor: poorly drained; high shrink-swell potential.
Edgeley: EdB, EdC, EdD.	Severe: shale at a depth of 30 to 60 inches.	Moderate to severe where slopes are less than 6 percent. Severe where slopes are greater than 6 percent; shale below a depth of 30 to 60 inches.	Moderate: clay loam; rippable shale below a depth of 30 to 60 inches.	Moderate: moderate shrink-swell potential; rippable shale below a depth of 30 to 60 inches.	Moderate: rippable shale below a depth of 30 to 60 inches.	Moderate: moderate shrink-swell potential.	Poor: moderate shrink-swell potential in solum; bedded shale below a depth of 30 to 60 inches; limited quantity of material.
*Embden: EmA, EmB, EnC. For Buse part of EnC, see Buse series.	Slight [2]	Severe: moderately rapid permeability.	Slight to moderate: well drained to moderately well drained.	Slight to moderate: well drained to moderately well drained.	Severe: moderately rapid permeability.	Moderate: more than 30 percent fines.	Fair: more than 30 percent fines.
Estelline: EsA	Slight [2]	Severe: rapid permeability in substratum.	Severe: sand and gravel below a depth of 30 to 40 inches.	Slight	Severe: rapid permeability in substratum.	Slight	Good
*Exline: ExA [3] For Aberdeen part, see Aberdeen series.	Severe: very slow permeability.	Slight	Severe: somewhat poorly drained; silty clay.	Severe: high shrink-swell potential.	Severe: silty clay	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
Fordville: FoA, FoB	Slight [2]	Severe: rapid permeability in substratum.	Severe: sand and gravel below a depth of 20 to 36 inches.	Slight	Severe: rapid permeability in substratum.	Slight	Good

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Poor: poorly drained.	Moderately slow permeability; seasonal high water table.	Fair stability and compaction characteristics; medium compressibility; moderately slow permeability.	Poorly drained; seasonal high water table; hazard of flooding.	Seasonal high water table; generally not applicable.	Generally not applicable.	Generally not applicable.
Poor: seasonal high water table; more than 15 percent fines in places.	Good	Seasonal high water table; rapid permeability in sand and gravel.	Fair to good stability and compaction characteristics; low to medium compressibility; poor to good resistance to piping.	Seasonal high water table at a depth of 3 to 5 feet; rapid permeability in substratum.	Moderately slow water intake rate; low to moderate available water capacity; sand and gravel below a depth of 20 to 36 inches.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Poor: silty clay; poorly drained.	Very slow permeability; seasonal high water table.	Fair to poor stability and compaction characteristics; high compressibility.	Water table below a depth of 4 feet; very slow permeability.	Very slow intake rate; moderate available water capacity; seasonal high water table below a depth of 4 feet.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Good to a depth of 15 inches where slopes are less than 9 percent; Fair where slopes are 9 to 15 percent.	Moderate permeability; shale below a depth of 41 inches; hazard of seepage in fractured shale.	Bedded shale below a depth of 30 to 60 inches.	Moderate permeability; bedded shale below a depth of 30 to 60 inches.	Moderate available water capacity; slopes of 2 to 15 percent; shale below a depth of 30 to 60 inches.	Fair stability; bedded shale below a depth of 30 to 60 inches.	Hazard of erosion on slopes; moderate available water capacity.
Poor for sand: more than 15 percent fines; no gravel.	Good: subject to soil blowing.	Moderately rapid permeability.	Good stability; fair to good compaction characteristics; slight compressibility; poor resistance to piping.	Moderately rapid permeability.	Moderately rapid water intake rate; moderate to high available water capacity.	Susceptible to soil blowing; moderately rapid permeability.	Moderate to high available water capacity; hazard of erosion; sandy.
Poor to good below a depth of 30 inches depending on percentage of fines.	Good	Rapid permeability in substratum.	Rapid permeability when compacted; poor to good resistance to piping of substratum material; fair to good stability.	Rapid permeability in sand and gravel substratum.	Moderately slow water intake rate; moderate available water capacity; sand and gravel below a depth of 30 to 40 inches.	Underlain by sand and gravel; rapid permeability below a depth of 30 inches.	Moderate available water capacity; sand and gravel below a depth of 30 inches.
Unsuited: no sand or gravel.	Poor: silty clay below a depth of 4 inches.	Very slow permeability; seasonal high water table.	Fair to poor stability and compaction characteristics; high compressibility.	Very slow permeability; seasonal high water table at a depth of 4 to 8 feet.	Very slow permeability; salts in subsoil and substratum; generally not applicable.	Very slow permeability; slopes of less than 2 percent; generally not applicable.	Claypan subsoil; low to moderate available water capacity; somewhat poorly drained.
Good to poor depending on fines.	Good	Rapid permeability in substratum; high seepage.	Moderate to high permeability when compacted; poor to good resistance to piping of substratum material.	Rapid permeability in substratum; sand and gravel below a depth of 20 to 36 inches.	Low to moderate available water capacity; moderate water intake rate; sand and gravel below a depth of 20 to 36 inches.	Rapid permeability below a depth of 20 to 36 inches; sand and gravel substratum limits channel cuts.	Hazard of erosion where sloping; low to moderate available water capacity; sand and gravel below a depth of 20 to 36 inches.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fills [1]	Local roads and streets	Road fill
Forman: FrA, FrB, FrC, FrD, FsC2, FsE, FtD, FxC, FxD. For Aastad part of FrA, FrB, FrC, and FrD, see Aastad series; for Buse part of FsC2, FsE, and FtD, see Buse series; for Poinsett part of FxC and FxD, see Poinsett series.	Severe: moderately slow permeability in underlying material.	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes are greater than 6 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are greater than 15 percent; clay loam.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: clay loam.	Severe: moderate to high shrink-swell potential; AASHO Group Index more than 8.	Poor: AASHO Group Index more than 8; moderate to high shrink-swell potential.
*Great Bend: GbB, GdA, GeB, GeC. For Beotia part of GdA, see Beotia series; for Zell part of GeB and GeC, see Zell series.	Moderate: moderate permeability.	Moderate where slopes are less than 6 percent. Severe where slopes are greater than 6 percent; moderate permeability.	Slight	Slight to moderate: low to moderate shrink-swell potential.	Slight	Severe: AASHO Group Index more than 8.	Poor: AASHO Group Index more than 8; high susceptibility to frost heave.
Hamar: Ha, Hd	Severe: high water table.	Severe: high water table.	Severe: high water table at a depth of 1 to 3 feet; poorly drained to somewhat poorly drained.	Severe: poorly drained to somewhat poorly drained.	Severe: high water table; rapid permeability.	Moderate to severe: somewhat poorly drained to poorly drained.	Fair to poor: somewhat poorly drained to poorly drained.
Hamerly Mapped only with Peever soils.	Severe: seasonal high water table.	Moderate to severe: seasonal high water table at a depth of 3 to 4 feet.	Moderate: moderately well drained to somewhat poorly drained; seasonal high water table at a depth of 3 to 4 feet.	Moderate to severe: moderate shrink-swell potential; moderately well drained to somewhat poorly drained	Severe: seasonal high water table.	Moderate: moderate shrink-swell potential.	Fair: moderate shrink-swell potential.
*Harmony: HeA For Aberdeen part, see Aberdeen series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate to severe: moderately well drained; silty clay and silty clay loam.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: silty clay loam and silty clay.	Moderate to severe: moderate to high shrink-swell potential.	Fair to poor: moderate to high shrink-swell potential.
*Hecla: HfA, HhA, HvB2. For Hamar part of HhA, see Hamar series; for Venlo part of HvB2, see Venlo series.	Slight to moderate: water table at a depth of 4 to 10 feet.[2]	Severe: rapid permeability.	Severe: sandy	Moderate: moderately well drained.	Severe: rapid permeability.	Slight	Good
*Kloten: KbE For Buse part, see Buse series.	Severe: steep; shale below a depth of 10 to 20 inches.	Severe: steep; shale below a depth of 10 to 20 inches.	Severe: steep; shale below a depth of 10 to 20 inches.	Severe: slopes are greater than 15 percent; shale below a depth of 10 to 20 inches.	Moderate where slopes are 15 to 25 percent. Severe where slopes are greater than 25 percent; rippable shale below a depth of 10 to 20 inches.	Severe: steep	Poor: shale below a depth of 10 to 20 inches; limited quantity of material.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Good where slopes are less than 9 percent. Fair where slopes are 9 to 15 percent.	Moderate permeability in subsoil and moderately slow in underlying material.	Fair to good stability and compaction characteristics; medium compressibility; good resistance to piping.	Moderately slow permeability in substratum.	High available water capacity; slow water intake rate; salt layers in substratum in places; hazard of erosion where sloping.	Short irregular slopes; moderately slow permeability in substratum.	High available water capacity; hazard of erosion where sloping; well drained.
Unsuited: no sand or gravel.	Good	Moderate permeability.	Fair to poor stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Moderate permeability.	High available water capacity; moderate water intake rate; hazard of erosion where sloping.	Moderate permeability; slopes are generally short and irregular.	Hazard of erosion where sloping; moderate permeability.
Poor for sand: more than 15 percent fines; unsuited for gravel.	Poor: sandy	Favorable for dugouts; high water table.	Fair stability; poor resistance to piping; erodible; fair to good compaction characteristics.	High water table; rapid permeability.	High water table; low to moderate available water capacity.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Good to a depth of 8 inches, fair below; loam to a depth of 8 inches, clay loam below.	Moderate permeability; seasonal high water table.	Fair to poor stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Seasonal high water table at a depth of 3 to 4 feet.	High available water capacity; seasonal high water table at a depth of 3 to 4 feet; high lime content; moderately slow water intake rate.	Short irregular slopes; high lime content; moderately slow permeability in substratum.	High available water capacity; high lime content; moderately well drained to somewhat poorly drained.
Unsuited: no sand or gravel.	Fair to a depth of 8 inches, poor below; silty clay loam to a depth of 8 inches, silty clay below.	Moderate permeability; lenses of fine sand in substratum in places.	Fair to poor stability and compaction characteristics; fair to poor resistance to piping; medium to high compressibility.	Moderate permeability.	High available water capacity; slow water intake rate; salt layers in substratum in places.	Fair to poor stability; slopes of less than 2 percent; moderate permeability.	High available water capacity; slopes of less than 2 percent; moderately well drained.
Poor for sand: more than 15 percent fines; unsuited for gravel.	Poor: sandy	High seepage; rapid permeability.	Good stability; erodible; fair to good compaction characteristics; poor resistance to piping.	Rapid permeability; water table at a depth of 4 to 10 feet.	Low to moderate available water capacity; very rapid water intake rate; susceptible to soil blowing.	Susceptible to soil blowing; rapid permeability.	Susceptible to soil blowing; low to moderate available water capacity.
Unsuited: no sand or gravel.	Poor: steep	Steep; seepage excessive in fractured shale in places.	Shale below a depth of 10 to 20 inches; subject to slippage; limited quantity of material.	Steep; shale below a depth of 10 to 20 inches.	Shallow to shale; generally not applicable.	Shale below a depth of 10 to 20 inches; steep.	Hazard of erosion; shale below a depth of 10 to 20 inches.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfills [1]	Local roads and streets	Road fill
*Kranzburg: KnA, KnB, KnC2, KrA, KrB. For Aberdeen part of KrA and KrB, see Aberdeen series.	Severe: moderately slow permeability in substratum.	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes are greater than 6 percent.	Moderate: clay loam.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: clay loam in substratum.	Severe: moderate to high shrink-swell potential; AASHO Group Index more than 8.	Poor: AASHO Group Index more than 8; moderate to high shrink-swell potential.
Lamoure: La	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table; somewhat poorly drained to poorly drained.	Severe: somewhat poorly drained to poorly drained; subject to flooding; moderate to high shrink-swell potential.	Severe: subject to flooding.	Severe: subject to flooding.	Poor: moderate to high shrink-swell potential; high susceptibility to frost heave.
Larson Mapped only with Swenoda soils.	Severe: slow permeability.	Slight	Moderate: moderately well drained.	Moderate: moderate shrink-swell potential.	Moderate: clay loam in subsoil.	Moderate: moderate shrink-swell potential.	Fair: moderate shrink-swell potential.
Loamy alluvial land: Lo. Too variable for valid interpretation.							
Ludden: Lu	Severe: very slow permeability; high water table.	Severe: subject to flooding; high water table.	Severe: poorly drained; subject to flooding; high water table.	Severe: poorly drained; high shrink-swell potential.	Severe: subject to flooding; high water table.	Severe: poorly drained; subject to flooding; high shrink-swell potential.	Poor: poorly drained; high shrink-swell potential.
Maddock: MaB, MaD.	Slight where slopes are less than 9 percent. Moderate where slopes are greater than 9 percent.[2]	Severe: rapid permeability.	Severe: sandy	Slight where slopes are less than 9 percent. Moderate where slopes are greater than 9 percent.	Severe: rapid permeability.	Slight where slopes are less than 9 percent. Moderate where slopes are 9 to 15 percent.	Good
Marsh: Mr. Too variable for valid interpretation.							
Oldham: Od, Oh	Severe: slow permeability; seasonal high water table.	Severe: seasonal high water table; subject to flooding.	Severe: poorly drained; subject to flooding; seasonal high water table.	Severe: poorly drained; subject to flooding; moderate to high shrink-swell potential.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Poor: moderate to high shrink-swell potential; moderate to high susceptibility to frost heave; poorly drained.
Parnell: Pa	Severe: slow permeability; subject to flooding.	Severe: seasonal high water table; subject to flooding.	Severe: poorly drained; subject to flooding; seasonal high water table.	Severe: poorly drained; subject to flooding; high shrink-swell potential.	Severe: poorly drained; subject to flooding: high shrink-swell potential.	Severe: poorly drained; subject to flooding; high shrink-swell potential.	Poor: high shrink-swell potential; poorly drained.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Good	Moderately slow permeability in substratum; low seepage.	Fair to good stability and compaction characteristics; medium to high compressibility; good resistance to piping.	Moderately slow permeability in substratum; level to sloping areas.	Slow water intake rate; high available water capacity; erodible on slopes.	Smooth slopes; erodible.	Hazard of erosion; high available water capacity; nearly level to sloping areas; well drained.
Unsuited: no sand or gravel.	Poor: poorly drained.	Seasonal high water table; sand and gravel below a depth of 40 inches in places.	Moderate to high shrink-swell potential; poor stability and compaction characteristics; medium to very high compressibility.	Seasonal high water table at a depth of 2 to 5 feet; subject to flooding.	Slow water intake rate; subject to flooding; high available water capacity.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Good to a depth of 8 inches, fair below; clay loam below a depth of 8 inches.	Slow permeability; low seepage.	Fair to poor stability and compaction characteristics; slight to medium compressibility; good to poor resistance to piping.	Slow permeability; nearly level areas.	High available water capacity; slow intake rate; susceptible to salt accumulation.	Slopes of less than 2 percent; slow permeability; salt in substratum and subsoil.	Slopes of less than 2 percent; high available water capacity; slow permeability; moderately well drained.
Unsuited: no sand or gravel.	Poor: poorly drained; clay.	Very slow permeability; high water table.	Fair to poor stability and compaction characteristics; high compressibility.	Very slow permeability; subject to flooding.	Very slow intake rate; moderate available water capacity; susceptible to salt accumulation.	Generally not applicable.	Generally not applicable.
Poor for sand: more than 15 percent fines; no gravel.	Poor: sandy	Rapid permeability; high seepage.	Good stability; fair to good compaction characteristics; poor resistance to piping.	Rapid permeability; sandy.	Low available water capacity; rapid water intake rate.	Sandy; rapid permeability; hazard of soil blowing.	Hazard of erosion; low available water capacity; sandy.
Unsuited: no sand or gravel.	Poor: poorly drained.	Seasonal high water table; low seepage; slow permeability.	Moderate to high shrink-swell potential; good to poor stability and compaction characteristics; medium to high compressibility.	Slow permeability; seasonal high water table; subject to flooding.	Slow intake rate; needs drainage; susceptible to salt accumulation.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Poor: poorly drained.	Seasonal high water table; low seepage; slow permeability; favorable for dugouts.	Fair to poor stability and compaction characteristics; good resistance to piping; high compressibility.	Slow permeability; seasonal high water table; wet areas lower than available outlets.	Subject to ponding; needs drainage.	Generally not applicable.	Generally not applicable.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfills [1]	Local roads and streets	Road fill
*Peever: PeA, PeB, PeC, PhA. For Hamerly part of PhA, see Hamerly series.	Severe: slow permeability.	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes are greater than 6 percent.	Moderate: clay loam.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: clay loam.	Severe: moderate to high shrink-swell potential; AASHO Group Index more than 8.	Poor: moderate to high shrink-swell potential; AASHO Group Index more than 8.
Playmoor: Pm	Severe: high water table; frequent flooding; moderately slow permeability.	Severe: frequent flooding; high water table.	Severe: poorly drained; high water table at a depth of 1 to 3 feet.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Poor: poorly drained; high susceptibility to frost heave.
*Poinsett: PoB, PwA, PwB. For Forman part of PoB, see Forman series; for Waubay part of PwA and PwB, see Waubay series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Severe: AASHO Group Index more than 8.	Poor: AASHO Group Index more than 8; moderate shrink-swell potential.
*Renshaw: RfA, RfB, RfC. For Fordville part of RfA, RfB, and RfC, see Fordville series.	Slight [2]	Severe: rapid permeability in substratum.	Severe: sand and gravel below a depth of 17 inches.	Slight	Severe: rapid permeability in substratum.	Slight	Good
Sandy lake beaches: Sa. Too variable for valid interpretation.							
*Serden: SdD2, SeB. For Venlo part of SeB, see Venlo series.	Slight where slopes are less than 9 percent. Moderate where slopes are 9 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: rapid permeability.	Severe: sandy	Slight where slopes are less than 9 percent. Moderate where slopes are 9 to 15 percent. Severe where slopes are greater than 15 percent.	Severe: rapid permeability.	Slight where slopes are less than 9 percent. Moderate where slopes are 9 to 15 percent. Severe where slopes are greater than 15 percent.	Good where slopes are less than 15 percent. Fair where slopes are greater than 15 percent.
Sieche: ShD, ShF	Severe: sloping to steep.	Severe: slopes are greater than 6 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are greater than 15 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are greater than 15 percent.	Slight where slopes are less than 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are greater than 25 percent.	Moderate where slopes are 6 to 15 percent. Severe where slopes are greater than 15 percent; moderate to high shrink-swell potential.	Fair to poor where slopes are less than 25 percent. Poor where slopes are greater than 25 percent; moderate to high shrink-swell potential.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Fair: clay loam	Slow permeability; low seepage.	Fair to poor stability and compaction characteristics; high compressibility.	Slow permeability; nearly level to sloping areas.	Slow water intake rate; moderate to high available water capacity; erodible on slopes.	Slow permeability; nearly level to sloping areas.	Erodible; moderate to high available water capacity; well drained.
Unsuited: no sand or gravel.	Poor: salinity; poorly drained.	High water table; low seepage; moderately slow permeability.	Moderate to high shrink-swell potential; fair to poor stability and compaction characteristics; medium to high compressibility.	High water table; subject to flooding.	High water table; high salt content.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Good to a depth of 13 inches; fair below; silty clay loam below a depth of 13 inches.	Moderate permeability.	Poor to fair stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Moderate permeability; nearly level to gently sloping areas.	Moderately slow water intake rate; high available water capacity; erodible on slopes.	Erodible; slopes generally short and irregular.	Erodible; high available water capacity; well drained.
Good to poor: 0 to 25 percent fines.	Poor: sand and gravel substratum below a depth of 17 inches.	High seepage; gravel below a depth of 17 inches.	Good stability; good to poor resistance to piping.	Rapid permeability in substratum.	Rapid water intake rate; low available water capacity.	Shallow to gravel; rapid permeability in substratum.	Difficult to maintain; shallow to sand and gravel.
Poor for sand: more than 15 percent fines; no gravel.	Poor: fine sand	Rapid permeability; high seepage.	Good stability; erodible; fair to good compaction characteristics; poor resistance to piping.	Rapid permeability; sandy.	Rapid intake rate; low available water capacity; susceptible to soil blowing; sloping areas.	Rapid permeability; susceptible to soil blowing; fine sand.	Susceptible to soil blowing; fine sand; sloping areas.
Unsuited: no sand or gravel.	Fair to poor: excessive slope.	Steep	Fair to poor stability and compaction characteristics; medium to high compressibility.	Steep	Steep; generally not applicable.	Steep; erodible	Steep; erodible.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fills [1]	Local roads and streets	Road fill
Sinai: SkA, SkB, SkC.	Severe: slow permeability.	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes are 6 to 9 percent.	Severe: silty clay...	Severe: high shrink-swell potential.	Severe: silty clay...	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
*Sioux: SmE..... For Arvilla part, see Arvilla series.	Severe: slopes are greater than 15 percent.[2]	Severe: rapid permeability.	Severe: very shallow to gravel.	Severe: slopes are greater than 15 percent.	Severe: rapid permeability.	Severe: slopes are greater than 15 percent.	Fair where slopes are 15 to 25 percent. Poor where slopes are 25 to 40 percent.
*Stirum: Su..... For Ulen part, see Ulen series.	Severe: high water table.	Severe: high water table.	Severe: poorly drained; high water table.	Severe: poorly drained.	Severe: poorly drained; subject to flooding.	Severe: poorly drained.	Poor: poorly drained; moderate to high susceptibility to frost heave.
*Swenoda: SwA, SwB, SxA. For Larson part of SxA, see Larson series.	Slight to moderate: moderate permeability in substratum.	Moderate: moderate permeability in substratum.	Slight.....	Slight to moderate: low to moderate shrink-swell potential; well drained to moderately well drained.	Slight.....	Moderate: AASHO Group Index of 4 to 8 in substratum.	Fair: AASHO Group Index of 4 to 8 in substratum.
Tonka: To.....	Severe: slow permeability; subject to ponding.	Slight if water is likely to enter lagoon.	Severe: poorly drained; subject to ponding.	Severe: poorly drained; moderate to high shrink-swell potential.	Severe: poorly drained.	Severe: poorly drained; moderate to high shrink-swell potential.	Poor: poorly drained; moderate to high shrink-swell potential; high susceptibility to frost heave.
*Ulen: Uf, Us..... For Stirum part of Us, see Stirum series.	Severe: seasonal high water table.	Severe: rapid permeability.	Severe: seasonal high water table; loamy fine sand below a depth of 24 inches.	Moderate to severe: moderately well drained to somewhat poorly drained.	Severe: seasonal high water table.	Moderate: moderately well drained to somewhat poorly drained; moderate susceptibility to frost heave.	Fair: moderately well drained to somewhat poorly drained; moderate susceptibility to frost heave.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Poor: clayey	Low seepage; slow permeability.	Fair to poor stability and compaction characteristics; high shrink-swell potential; high compressibility.	Slow permeability; clayey.	Very slow water intake rate; moderate to high available water capacity.	Clayey; slow permeability; nearly level to sloping areas.	Clayey; moderate to high available water capacity; well drained.
Good to poor: 0 to 25 percent fines.	Poor: sand and gravel at a depth of 7 to 14 inches.	High seepage; rapid permeability; sand and gravel substratum at a depth of 7 to 14 inches.	Good stability; fair to poor resistance to piping.	Rapid permeability; slopes are greater than 15 percent.	Low available water capacity; shallow rooting zone; sloping to very steep areas; generally not applicable.	Very shallow to gravel; rapid permeability.	Very shallow to gravel; low available water capacity.
Poor for sand: more than 15 percent fines; high water table; no gravel.	Poor: poorly drained.	High water table; moderately rapid permeability in substratum.	Poor resistance to piping.	Moderately slow permeability in subsoil, moderately rapid permeability in substratum; high water table; claypan subsoil.	Low to moderate available water capacity; poorly drained; high water table; subject to salt accumulation in subsoil and substratum; generally not applicable.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Good	Moderately rapid permeability in upper 29 inches; moderate below.	Fair to poor stability; fair to poor shear strength.	Moderately rapid permeability in upper 29 inches, moderate permeability below; nearly level to gently sloping areas.	High available water capacity; susceptible to soil blowing; moderately slow water intake rate.	Susceptible to soil blowing; moderately rapid permeability; in upper 29 inches; moderate permeability in substratum.	High available water capacity; susceptible to soil blowing.
Unsuited: no sand or gravel.	Poor: poorly drained.	Slow permeability; subject to ponding; high water table.	Fair to poor stability and compaction characteristics; medium to high compressibility.	Slow permeability subject to ponding; wet areas lower than available outlets.	Subject to ponding; very slow intake rate; high available water capacity; poorly drained; generally not applicable.	Generally not applicable.	Generally not applicable.
Poor for sand: more than 15 percent fines; no gravel.	Poor: seasonal high water table.	Seasonal high water table; rapid permeability.	Good stability; fair to good compaction characteristics; low compressibility; poor resistance to piping.	Rapid permeability; seasonal high water table; sandy substratum.	Very rapid intake rate; seasonal high water table; low available water capacity; generally not applicable.	Generally not applicable.	Generally not applicable.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—						Suitability as source of—
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfills [1]	Local roads and streets	Road fill
Vallers: Va	Severe: moderately slow permeability; seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained.	Severe: poorly drained; high susceptibility to frost heave.
Venlo Mapped only in complex with Hecla and Serden soils.	Severe: high water table; subject to flooding.	Severe: high water table; subject to flooding.	Severe: very poorly drained; high water table; subject to flooding.	Severe: very poorly drained; subject to flooding.	Severe: very poorly drained; high water table; subject to flooding.	Severe: very poorly drained; subject to flooding.	Poor: very poorly drained.
Waubay Mapped only with Poinsett soils.	Severe: moderately slow permeability in substratum.	Moderate: moderate permeability in subsoil.	Moderate: moderately well drained.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: moderately well drained; silty clay loam.	Severe: moderate to high shrink-swell potential; AASHO Group Index more than 8.	Poor: moderate to high shrink-swell potential; AASHO Group Index more than 8.
Wet alluvial land: Wa. Too variable for valid interpretation.							
Zell Mapped only with Great Bend soils.	Slight	Moderate where slopes are 2 to 6 percent. Severe where slopes are greater than 6 percent.	Slight	Slight	Slight	Moderate: AASHO Group Index of 4 to 8.	Fair: ML material; AASHO Group Index of 4 to 8.

[1] If the land fill is to be at a depth of more than 5 or 6 feet, onsite investigations are needed to determine the depth to the water table and the hazard of contamination of aquifers and of ground-water drainage.

engineering properties of the soils—Continued

Suitability as source of—Continued		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited: no sand or gravel.	Poor: poorly drained.	Moderately slow permeability; seasonal high water table.	Fair to good stability and compaction characteristics; medium to high compressibility.	Moderately slow permeability; seasonal high water table.	High available water capacity; seasonal high water table; susceptible to salt accumulation; generally not applicable.	Generally not applicable.	Generally not applicable.
Poor for sand: more than 15 percent fines; no gravel.	Poor: very poorly drained.	High water table; rapid permeability.	Good stability; fair to good compaction characteristics; low compressibility; poor resistance to piping.	High water table; wet areas lower than available outlets.	Low available water capacity; needs drainage; water table at a depth of less than 3 feet; susceptible to soil blowing; generally not applicable.	Generally not applicable.	Generally not applicable.
Unsuited: no sand or gravel.	Fair: silty clay loam.	Low seepage; moderately slow permeability in substratum.	Fair to good stability; medium to high compressibility.	Moderately slow permeability in substratum; nearly level to gently sloping areas.	Moderately slow water intake rate; high available water capacity.	Plane or concave slopes; slopes are generally less than 3 percent.	High available water capacity; moderately well drained; nearly level to gently sloping areas.
Unsuited: no sand or gravel.	Good	Moderate permeability.	Fair to poor stability and compaction characteristics; medium compressibility; poor resistance to piping.	Moderate permeability; gently sloping to sloping areas.	Moderate water intake rate; hazard of erosion where sloping; moderate to high available water capacity.	Hazard of erosion at outlets; short, steep slopes; moderate permeability.	Erodible; moderate to high available water capacity; gently sloping to sloping areas.

[2] Possible source of pollution for domestic water supplies.
[3] During wet years water table may rise above a depth of 5 feet.

TABLE 7.—*Engineering*

[Tests were made by the South Dakota Department of Highways in accordance with standard

Soil name and location	Parent material	Report No.	Depth	Moisture-density [1]	
				Maximum dry density	Optimum moisture
			Inches	*Percent*	*Percent*
Beotia silt loam:					
500 feet E. and 150 feet N. of S. quarter corner of sec. 9, T. 126 N., R. 59 W. (Modal)	Lacustrine silts.	1745	15–25	102	17
		1746	32–42	110	16
		1747	42–60	105	16
Embden fine sandy loam:					
280 feet W. and 60 feet S. of E. quarter corner of sec. 32, T. 128 N., R. 58 W. (Modal)	Eolian sands of lacustrine origin.	1743	15–34	106	14
		1744	34–40	106	14
Exline silty clay loam:					
1,100 feet N. and 100 feet E. of SW. corner of sec. 27, T. 126 N., R. 58 W. (Modal)	Lacustrine silts and clays.	1748	0–8	80	33
		1749	11–19	80	35
		1750	19–40	86	30
		1751	40–52	98	23
Fordville loam:					
860 feet S. and 80 feet E. of NW. corner of sec. 33, T. 125 N., R. 53 W. (Modal)	Alluvium over outwash sand and gravel.	1758	10–17	102	18
		1759	20–25	112	13
		1760	25–60	117	13
Harmony silty clay loam:					
1,200 feet E. and 70 feet S. of NW. corner of sec. 6, T. 125 N., R. 58 W. (Modal)	Lacustrine silts and clays.	1752	8–17	86	29
		1753	28–40	107	17
		1754	40–60	96	22
Hecla loamy fine sand:	Eolian sands.	1764	0–12	102	15
2,130 feet W. and 165 feet N. of SW. corner of sec. 1, T. 128 N., R. 59 W. (Modal)		1765	18–27	103	14
		1766	39–55	106	15
Sinai silty clay:	Glacio-lacustrine clays and silts.	1755	8–19	87	29
1,670 feet E. and 210 feet N. of SW. corner of sec. 28, T. 125 N., R. 55 W. (Modal)		1756	19–28	94	24
		1757	50–60	100	24

[1] Based on the Moisture-density Relations of Soils Using 5.5-lb. Rammer and 12-in. Drop, AASHO Designation: T 99, Method A.

[2] Mechanical analyses according to the AASHO Designation: T 88 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method,

test data

procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than 0.005 mm.			AASHO [3]	Unified [4]
¾-in.	⅜-in.	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
						Percent			
			100	89	21	32	9	A–4(8)	ML–CL
			100	91	33	29	11	A–6(8)	CL
			100	98	20	31	8	A–4(8)	ML–CL
			100	31	6	21	1	A–2–4(0)	SM
			100	40	6	21	2	A–4(1)	SM
				100	58	71	31	A–7–5(30)	MH
			100	94	70	88	46	A–7–5(20)	MH
		100	99	95	62	75	39	A–7–5(20)	MH–CH
			100	99	66	55	30	A–7–6(20)	CH
	100	98	80	57	21	42	10	A–5(5)	ML
100	96	85	66	46	14	33	8	A–4(2)	SM–SC
100	88	57	18	4	1	20	1	A–1–B(0)	SW
			100	97	48	56	19	A–7–5(15)	MH
			100	98	36	35	15	A–6(10)	CL
			100	99	36	44	16	A–7–6(11)	ML–CL
			100	35	9	25	1	A–2–4(0)	SM
			100	32	7	23	1	A–2–4(0)	SM
			100	60	17	25	4	A–4(5)	ML–CL
		100	99	95	60	61	24	A–7–5(18)	MH
		100	99	95	64	58	25	A–7–5(18)	MH
			100	98	58	52	24	A–7–6(16)	MH–CH

and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 8): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145–49 (*1*).

[4] Based on the Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations (*11*).

TABLE 8.—*Engineering test data for soil*

[Tests were made by the South Dakota Department of Highways in Marshall County and in

Soil series	Horizon	No. of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Aastad	A	13	82–100	95	60–100	86	36–93	65
	B	16	94–100	97	83–96	90	59–82	70
	C	16	95–100	98	85–98	91	62–89	75
Aberdeen	A	56	97–100	100	91–100	98	66–100	87
	B	101	97–100	100	94–100	99	80–100	93
	C	54	93–100	99	86–100	97	66–100	88
Arveson	A	14	67–100	90	41–100	71	20–70	45
	2C	31	41–100	70	17–80	49	3–49	26
Beotia	A	59	99–100	100	96–100	99	77–100	89
	B	78	97–100	100	91–100	98	73–100	90
	C	119	96–100	100	89–100	98	70–100	91
Buse	C	114	89–100	95	76–99	87	46–85	66
Dovray	A	17	99–100	100	97–100	100	98–100	100
	B	6	94–100	98	94–100	97	94–100	98
	C	32	76–100	90	80–98	89	83–100	93
Embden	A	6	100	100	88–100	97	42–61	51
	B	7	93–100	97	68–98	83	26–62	44
	C	10	100	100	99–100	100	25–65	45
Estelline	A	11	99–100	100	89–100	94	62–100	82
	B	22	94–100	98	85–100	93	62–100	81
	C	19	87–100	95	72–100	87	36–98	67
	2C	17	50–90	70	25–75	50	6–45	26
Exline	B	30	98–100	100	91–100	98	76–100	91
	C	19	95–100	99	89–100	96	73–100	88
Fordville	A	34	84–100	95	63–100	82	37–83	60
	B	79	79–100	94	58–100	82	32–92	62
	C	58	58–100	84	23–100	68	0–99	47
	2C	39	39–100	70	14–84	49	0–49	24
Forman	A	89	94–100	98	85–99	92	57–87	72
	B	160	94–100	98	85–100	93	57–92	74
	C	383	90–100	96	80–100	90	53–91	72
Great Bend	A	20	98–100	99	92–100	97	38–100	70
	B	22	98–100	100	86–100	97	45–100	76
	C	94	94–100	98	84–100	95	43–100	75
Hamerly	C	38	83–100	95	71–100	87	42–88	65
Hecla	A	56	98–100	100	86–100	96	7–49	28
	C	83	87–100	97	68–100	92	6–43	24
Kranzburg	A	17	97–100	100	90–100	96	71–99	85
	B	107	96–100	99	87–100	95	68–100	84
	C	16	92–100	97	82–100	93	60–95	77
	2C	140	82–100	95	68–100	87	42–95	69
Lamoure	A	15	86–100	97	72–100	91	34–100	69
	B	23	86–100	96	44–100	80	17–100	60
	C	89	63–100	90	43–100	78	17–93	55

See footnotes at end of table.

samples taken along proposed highway routes

surrounding counties. Absence of data indicates that no estimate was made]

Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [7]
Range	Average	Range	Average	AASHO [4] (Old index)	AASHO [5] (New index)	Unified [6]	
Percent	*Percent*						
35–59	47	8–22	15	A–7–5(9)	A–7–5(10)	ML	4
32–56	44	13–30	21	A–7–5(12)	A–7–6(14)	CL	4
34–55	45	16–32	24	A–7–5(15)	A–7–6(18)	CL	4
34–52	43	10–25	17	A–7–5(11)	A–7–6(17)	ML–CL	4
40–72	56	19–46	32	A–7–6(19)	A–7–6(34)	CH	3
27–56	42	5–34	19	A–7–6(12)	A–7–6(18)	CL	5
22–53	37	5–16	10	A–6(2)	A–6(2)	SM–SC	6
11–42	27	1–19	9	A–2–4(0)	A–2–4(0)	SC	----------
34–49	41	8–18	13	A–7–6(9)	A–7–6(14)	ML–CL	5
31–50	41	7–25	16	A–7–6(11)	A–7–6(16)	ML–CL	5
25–50	37	4–24	13	A–6(10)	A–6(13)	ML–CL	6
23–49	36	7–27	16	A–6(3)	A–6(9)	CL	6
41–65	53	14–36	24	A–7–6(17)	A–7–6(26)	MH–CH	3
47–77	62	22–55	38	A–7–6(20)	A–7–6(38)	CH	2
44–75	60	22–51	36	A–7–6(20)	A–7–6(38)	CH	2
2–50	26	0–17	6	A–4(3)	A–4(1)	ML–CL	11
17–42	30	1–15	8	A–4(2)	A–4(2)	SM–SC	8
9–34	21	1–6	3	A–4(1)	A–4(0)	SM	15
34–55	44	6–25	15	A–7–6(11)	A–7–6(14)	ML–CL	4
33–48	40	13–22	17	A–6(11)	A–6(14)	ML–CL	5
25–45	35	8–24	16	A–6(9)	A–6(9)	CL	6
15–28	22	1–13	6	A–2–4(0)	A–2–4(0)	SM–SC	----------
45–74	59	22–46	34	A–7–6(20)	A–7–6(19)	CH	2
33–78	55	12–48	29	A–7–6(35)	A–7–6(29)	CH	1
33–52	43	7–19	13	A–7–5(7)	A–7–5(7)	ML	4
28–48	38	9–22	15	A–6(7)	A–6(8)	ML–CL	6
18–51	34	1–25	13	A–6(3)	A–6(3)	SC	7
6–37	22	0–16	6	A–2–4(0)	A–2–4(0)	SM–SC	----------
37–52	45	10–22	15	A–7–6(11)	A–7–6(12)	ML–CL	4
35–51	43	12–28	19	A–7–6(12)	A–7–6(14)	CL	4
28–49	39	9–28	18	A–6(11)	A–6(12)	CL	5
19–55	37	2–20	10	A–6(7)	A–6(7)	ML–CL	6
26–48	37	3–21	12	A–6(9)	A–6(9)	ML–CL	6
17–45	31	1–19	9	A–4(8)	A–4(6)	ML–CL	8
24–49	36	7–25	16	A–6(8)	A–6(9)	CL	6
0–40	16	0–13	4	A–2–4(0)	A–2–4(0)	SM–SC	----------
0–37	14	0–14	4	A–2–4(0)	A–2–4(0)	SM–SC	----------
37–50	44	12–20	16	A–7–6(11)	A–7–6(15)	ML–CL	4
34–53	43	11–26	18	A–7–6(12)	A–7–6(16)	ML–CL	4
29–41	35	10–23	16	A–6(11)	A–6(11)	CL	6
24–48	36	9–27	18	A–6(10)	A–6(10)	CL	6
27–59	43	7–25	16	A–7–6(10)	A–7–6(11)	ML–CL	4
18–65	42	4–31	17	A–7–6(8)	A–7–6(9)	ML–CL	5
17–53	35	4–26	15	A–6(6)	A–6(6)	CL	6

TABLE 8.—*Engineering test data for soil*

Soil series	Horizon	No. of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Maddock	A	9	94–100	98	75–100	90	5–66	35
	B	8	66–100	91	39–100	76	7–56	31
	C	20	75–100	94	51–100	82	0–60	28
Parnell	B	16	95–100	99	87–100	96	66–100	85
	C	17	93–100	97	83–100	92	63–97	80
Peever	A	33	92–100	97	79–100	91	52–87	70
	B	40	93–100	98	84–100	92	65–88	76
	C	107	90–100	98	81–100	93	61–96	78
Playmoor	A	10	100	100	97–100	99	53–88	71
	B	5	99–100	100	92–100	98	47–100	76
	C	10	98–100	99	84–100	96	39–86	63
Poinsett	A	51	94–100	98	85–100	94	55–100	78
	B	131	93–100	98	86–100	95	59–100	81
	C	186	86–100	96	71–100	90	41–100	73
Renshaw	A	15	92–100	97	68–97	82	24–78	51
	B	20	75–100	93	43–100	74	9–65	37
	2C	54	40–100	74	9–89	49	0–41	18
Sinai	A	22	96–100	99	90–100	96	67–99	83
	B	61	93–100	99	88–100	96	67–100	86
	C	80	94–100	98	85–100	94	61–100	83
Sioux	A	16	57–100	84	35–100	68	15–78	46
	2C	72	36–94	65	11–75	43	0–45	21
Swenoda	A	10	85–100	96	71–100	90	32–52	42
	2C	10	94–100	98	77–100	92	39–95	67
Tonka	A	11	97–100	99	90–100	95	58–97	77
	B	19	93–100	97	86–100	94	68–100	84
	C	10	76–100	95	55–100	88	39–100	77
Ulen	A	5	100	100	100	100	35–56	46
	C	16	91–100	98	59–100	91	2–72	37
Waubay	B	16	93–100	97	86–100	94	66–100	84
	C	12	84–100	95	74–100	88	44–99	72
Zell	C	14	93–100	98	73–100	90	5–100	61

[1] Mechanical analyses according to the AASHO Designation T 88 (*1*). Results by this procedure may differ somewhat from the results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculations of grain-size fractions. The mechanical analyses data used in this table are not intended for naming textural classes of soil.

samples taken along proposed highway routes—Continued

Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [7]
Range	Average	Range	Average	AASHO[4] (Old index)	AASHO[5] (New index)	Unified [6]	
Percent	*Percent*						
0–48	22	0–21	6	A–2–4(0)	A–2–4(0)	SM–SC	----------
0–42	20	0–13	5	A–2–4(0)	A–2–4(0)	SM–SC	----------
0–37	16	0–10	3	A–2–4(0)	A–2–4(0)	SM–SC	----------
41–73	57	15–47	30	A–7–6(19)	A–7–6(29)	CH	3
35–63	49	13–38	25	A–7–6(16)	A–7–6(21)	CL	3
37–56	46	9–24	16	A–7–5(10)	A–7–5(11)	ML	4
37–63	50	14–36	24	A–7–6(16)	A–7–6(19)	CL	3
31–73	52	12–44	27	A–7–6(18)	A–7–6(23)	CH	3
24–41	33	7–20	13	A–6(9)	A–6(8)	CL	7
19–84	51	2–42	22	A–7–6(15)	A–7–6(15)	MH–CH	3
16–56	36	4–24	13	A–6(7)	A–6(7)	ML–CL	6
34–51	43	8–21	14	A–7–6(11)	A–7–6(12)	ML–CL	4
32–53	42	9–26	17	A–7–6(11)	A–7–6(15)	ML–CL	5
23–48	36	5–26	15	A–6(10)	A–6(10)	CL	6
19–55	37	3–17	9	A–4(3)	A–4(3)	ML–CL	6
14–42	28	0–18	9	A–4(0)	A–4(0)	SC	10
1–40	21	0–15	5	A–1–b(0)	A–1–b(0)	SM–SC	----------
46–63	54	10–32	20	A–7–5(15)	A–7–5(21)	MH	3
41–60	51	12–33	22	A–7–6(15)	A–7–6(22)	MH–CH	3
29–61	45	11–38	24	A–7–6(15)	A–7–6(20)	CL	4
21–57	39	4–21	12	A–6(3)	A–6(3)	SM–SC	5
6–40	23	0–16	7	A–2–4(0)	A–2–4(0)	SM–SC	----------
19–53	36	0–14	6	A–4(1)	A–4(0)	SM	6
23–39	31	4–20	12	A–6(7)	A–6(6)	CL	8
32–57	44	7–28	17	A–7–6(12)	A–7–6(14)	ML–CL	4
41–61	51	19–38	28	A–7–6(18)	A–7–6(25)	CH	3
26–66	46	8–40	23	A–7–6(15)	A–7–6(18)	CL	4
2–41	21	0–5	1	A–4(2)	A–4(0)	SM	15
0–39	16	0–11	3	A–4(0)	A–4(0)	SM	23
35–53	44	16–29	22	A–7–6(14)	A–7–6(19)	CL	4
27–54	40	9–31	20	A–6(11)	A–6(13)	CL	5
1–52	27	0–22	9	A–4(5)	A–4(3)	CL	10

[2] Based on AASHO Designation T 89–60 (*1*).
[3] Based on AASHO Designation T 90–61 (*1*).
[4] Based on AASHO Designation M 145–49 (*1*).
[5] Based on AASHO Designation M 145–66I (*1*).
[6] Based on the Unified Soil Classification System for Roads, Airfields, Embankments and Foundations (*11*).
[7] Estimated values based on relationships between California Bearing Ratio and liquid limit.

Soil features and qualities considered for drainage are those that affect the installation and performance of surface and subsurface systems.

Irrigation is influenced chiefly by soil features such as water intake rate, permeability, available water capacity, depth of rooting zone, susceptibility to stream overflow, salinity, stoniness, slope, hazard of soil blowing and water erosion, and presence of a layer that limits water movement.

The factors considered in planning and constructing terraces and diversions are those soil features and qualities that affect stability of the soils, layout and construction, sedimentation of terraces and diversions, and establishment and maintenance of vegetative cover and channels.

Areas where grassed waterways are needed are affected by seepage, pockets of sand and gravel, and the suitability of the soil for grasses.

Engineering test data

Table 7 lists data obtained by laboratory tests on samples from seven soil profiles. The tests were performed by the South Dakota Department of Highways. They were made in accordance with the standard procedures of the American Association of State Highway Officials (*1*). Some of the terms used in table 7 are explained in the following paragraphs.

Mechanical analyses show the actual range and average of the percentage, by weight, of soil particles that would pass sieves of specified sizes. Sand and other coarser material do not pass through the No. 200 sieve. Silt and clay pass through this sieve.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil increases from that found in a dry state, the material changes from a solid to a plastic. If the moisture content is further increased, the material changes from a plastic to a liquid. The *plastic limit* is the moisture content at which the soil material passes from a solid to a plastic. The *liquid limit* is the moisture content at which the material changes from a plastic to a liquid. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Table 8 lists data obtained from engineering tests made on soil samples along proposed highway routes in Marshall County and surrounding counties. These tests also were performed by the South Dakota Department of Highways.

Also listed in table 8 are the major horizons from which the samples were taken. The samples were taken at a depth that reflected distinct changes in color and texture; consequently, a specific soil is likely to include material from more than one major horizon. Because of this difference in sampling, the range in properties in table 8 is not necessarily the same as that shown in table 5.

A number of samples of each horizon of a given soil were tested. The range and the average values for each of several properties are shown in table 8. The AASHO and Unified classifications listed were based on average values.

Town and Country Planning

Information about the soil is important in planning the use or development of lands for nonfarm purposes. Land appraisers, realtors, city and county planners, builders, and others need facts that will help them determine what soils are suitable for homes and other buildings and what areas are better suited to other purposes. This information is obtained by using soil maps to identify the soils and then referring to the sections describing the soils and the use of the soils for tree plantings, engineering, and recreation. It is desirable, however, to make detailed samples and tests at the site of proposed buildings, roads, and streets.

Soil properties affect the suitability of a site for individual homes, for a subdivision involving several homes, or for light industrial buildings. In the section "Estimated soil properties significant to engineering," table 5 gives information on texture, permeability, shrink-swell potential, and corrosivity of soils and on the Unified soil classification. The Unified classification groups soils according to their performance as foundation materials. Information on the suitability of soils in the county for dwellings with basements is given in table 6.

Facilities for sewage disposal and garbage disposal and new roads and streets are frequently needed for subdivisions, individual homes, and industrial sites that are outside the limits of municipalities. Table 6 provides information on the suitability of the soils of the county for septic-tank absorption fields, sewage lagoons, sanitary land fill, and local roads and streets. Such information is useful to help ensure that developed facilities function properly and pollution of ground and surface water is avoided. Driveways, sidewalks, streets, and roads shift and crack when built on soils that have a high shrink-swell characteristic. This is an important consideration in locating such facilities.

Also in table 6 is information on the suitability of each soil as a source of topsoil. This information is helpful in establishing vegetative cover on borrow pits and cut banks of new roads as an erosion-control measure. Useful information for establishing new lawns, golf courses, parks, and other uses where vegetative cover is desired is also in table 6.

Town and country planning also includes the development of areas as campsites, athletic fields, golf courses, playgrounds, picnic areas, and paths and trails. Gentle slopes, good drainage, and a surface soil that has good consistence and foot-traffic qualities are desired. Probability of wetness from flooding, a high water table, and stoniness are limitations for such uses. The section "Description of the Soils" gives information on soil characteristics affecting these uses. Table 4 in the section "Use of the Soils for Recreation" rates the suitability of the soils of the county for recreational development.

Formation and Classification of Soils

This section consists of two main parts. The first explains how the factors of soil formation have affected the development of soils in Marshall County. The second explains the system of soil classification currently used

and places each soil series in some of the classes of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given time are determined by five factors: the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors in soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the development of horizons. Much or little time may be involved, but some time is always required for differentiation of soil horizons. The development of distinct horizons generally takes a long time.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material [10]

Parent material is the weathered, disintegrated or unconsolidated rock masses from which soils are formed. It determines the mineralogical and chemical composition of the soil and, to a large extent, the rate at which the soil-developing processes take place.

Two major geologic features in Marshall County account for the six types of parent material. The Coteau des Prairie dominates about 58 percent of the county (*4*). The remaining area is mainly Lake Dakota Plain (*5*).

The Coteau is a ridge of small hills having stagnant ice glacial features. The hilly topography of the Coteau consists of closely spaced knobs and marshy sloughs between them. Stream drainage is poorly developed, and the topography is almost completely glacial in origin. The land forms are the result of a continuous sheet of stagnant, or dead, ice. The characteristic glacial features on the Coteau des Prairie are dead ice moraine, collapsed-stream-sediment topography, collapsed-lake-sediment topography, ice-walled lake plains, and associated disintegrated ridges and trenches (*2*).

The Lake Dakota Plain area is mainly lacustrine deposits, dune sand, and loess derived from the lacustrine deposits.

The six main types of parent material are glacial till, glacial outwash, lacustrine deposits, dune sand, loess, and alluvium. The dune sand and loess materials are derived mainly from the lacustrine deposits of the Lake Dakota Plain. In each of the parent materials certain characteristics determine the types of material and their basic arrangement. The till areas of the Coteau are hilly and have many sloughs and potholes. The material is generally clay loam. The surface drainage pattern is poorly developed. The Forman-Aastad-Buse association is the largest group of soils in the till area. Soils of the Forman-Poinsett association formed in till and silty drift in the southern and northeastern parts of the county. Many dead ice features of Middle Wisconsin glaciation are in the till areas.

Glacial outwash, which consists of gravel, sand, and a very little silt and clay, is in the southeast corner and the east-central part of the county. The soils are generally well drained or excessively drained because the permeability of the outwash material is high. Soils of the Renshaw-Fordville-Sioux association formed in outwash.

The area west of the Coteau is mainly lacustrine sediment and sediment derived from the lacustrine Lake Dakota Plain. The lacustrine sediment is commonly fine-grained silt and clay that contains a little sand or gravel. The lake plain area is nearly flat. Post-glaciation stream erosion is the main topographic feature. Soils of the Beotia-Great Bend and Harmony-Aberdeen-Exline associations formed in lake plain sediment.

Dune sand and eolian sandy silt, derived from the lacustrine sediment, are prominent in the northwestern part of the county. Soils in the Embden-Hecla-Ulen association and in the Maddock-Serden association formed in dune sand and silty eolian sediment.

A thin mantle of loess over till extends along the west margin of the Coteau nearly to the North Dakota border. The material is silty and probably was derived from the lacustrine sediment to the northwest. The area is well dissected by drainageways. The Kranzburg soils formed in this material (fig. 32).

In the northeast corner of the county are lake plain sediment and deposits of alluvium. The materials are fine grained and slowly permeable. The lake plain material is of the Late Wisconsin age, and the alluvium is of the Late Wisconsin and Recent ages. Soils of the Dovray-Ludden-Lamoure association formed in these materials. Alluvium of recent age is also in the valleys of most of the streams in other associations.

Climate

Climate is a factor of soil formation because temperature and precipitation have a direct influence on the rates of chemical and physical processes of weathering. Marshall County has a typical continental climate, which is marked by extreme seasonal temperature changes. The average annual air temperature is 43° F. The average for January is 10° F., and the average for July is 72° F. The low temperatures have promoted the accumulation of organic matter and the dark color in the surface layer of the soils. The soils are frozen about 120 days most years.

The annual precipitation is about 20 inches. Prolonged periods of drought followed by periods of high precipitation are common. The lack of sufficient moisture causes lime to accumulate at moderate depths in most soils.

[10] By JAMES R. MONAGHAN, geologist, Soil Conservation Service.

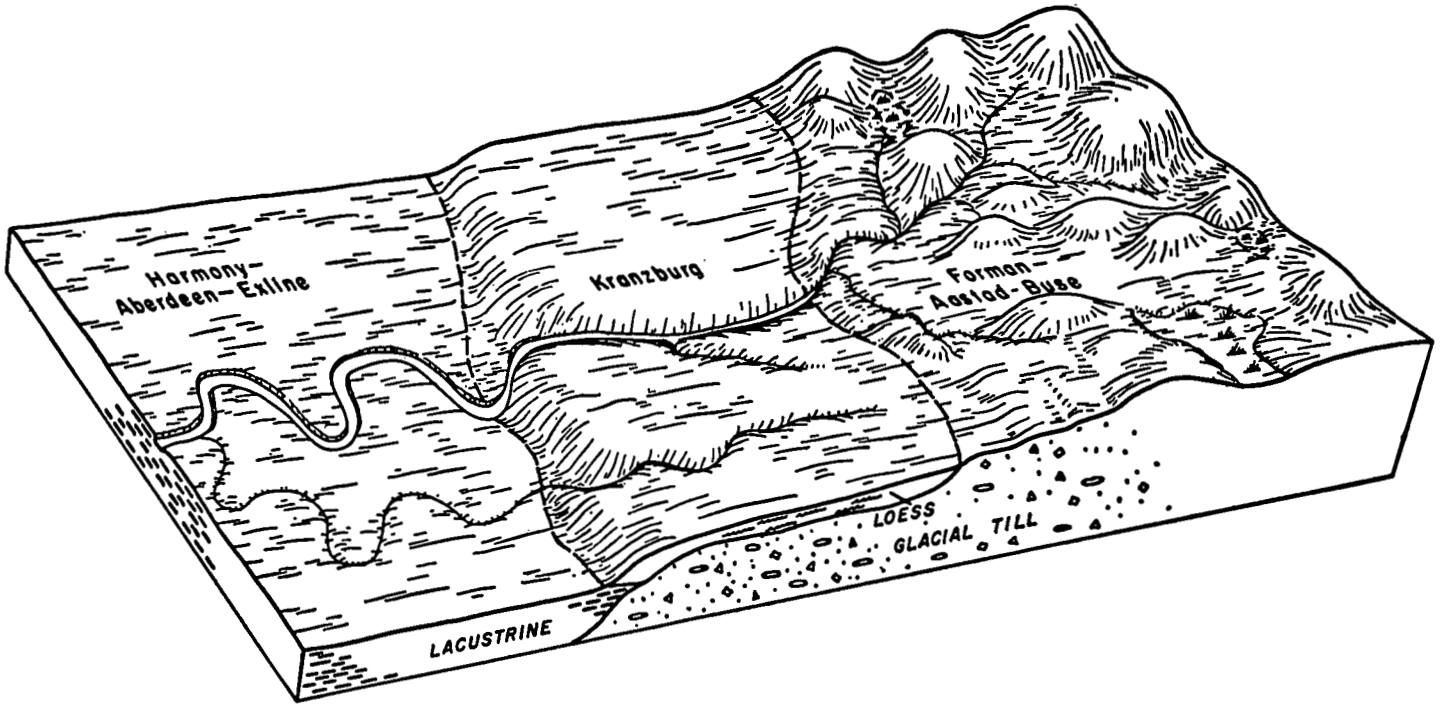

Figure 32.—**Relative position of the Kranzburg association in the south-central part of the county.**

More detailed information on climate is in the section "General Nature of the County."

Plant and animal life

All living organisms play an important part in soil formation. These include vegetation, animals, bacteria, and fungi. The vegetation is generally the cause of the amount of organic matter, the color of the surface layer, and the amount of nutrients. Animals, such as earthworms, cicada, and burrowing animals, help keep the soil open and porous. In Marshall County, however, burrowing animals, such as pocket gophers, have become so numerous that they have become a pest on idle land. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

In Marshall County mid and tall, mixed prairie grasses have had more influence on soil formation than any other living organisms. Consequently, soils have a high amount of organic matter in the surface layer and reactions, generally favorable to plant growth, have been created without requiring soil amendments, such as lime.

Relief

The relief, or the lay of the land, affects the soil by influencing its drainage, erosion, plant cover, and soil temperature. Slope ranges from less than 1 percent on the lacustrine lake plain of western Marshall County to over 40 percent on the steep slopes leading from the Sisseton Hills. Soils that have east- and north-facing slopes have soil temperatures that are slightly lower than those that have west- and south-facing slopes.

Steep soils, such as those of the Buse series, have a limy, thin surface layer, whereas the more gently sloping Forman soils have a dark-colored, thick surface layer. Soils of both of these series, however, formed in similar material. Excessive runoff from the steep slopes and the higher rate of erosion have retarded the soil formation of the Buse soils. Soils such as Aastad are in positions on the landscape that receive additional moisture. They have a thicker and darker colored solum, and generally the lime is leached to greater depths. Soils in positions that are affected by a fluctuating water table generally have a very dark-colored surface layer and are mottled. Some soils may be limy or contain soluble salts brought upward in the soil solution and precipitated in the upper layers when the soil dries out. Colvin and Ulen soils are examples.

Time

The formation of soils requires many years for changes to take place in the parent material. The age of a soil, however, is determined by the degree of soil development in the profile. Soils with little or no development are immature, whereas those with well-expressed horizons are mature, even if the parent material from which they formed is the same age in years.

Soils in the county range from immature to mature. Soils that formed on low bottoms and are subject to varying degrees of overflow receive new sediment with each flooding. These soils have a thick, dark-colored surface layer, but their soil structure is weak. The continual addition of sediment and other unfavorable conditions have retarded soil formation. An example is the Lamoure soils. The Buse soils are considered immature because they lack well-developed horizons, even though they formed in material of the same age as Forman and Peever soils. Forman and Peever soils are mature.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*7*, *9*). In table 9, the soil series of Marshall County are placed in some categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that soils of similar genesis, or mode of origin, can be grouped together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDERS.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The proper-

TABLE 9.—*Soils classified according to the current system of classification*

Series	Family	Subgroup	Order
Aastad	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Aberdeen	Fine, montmorillonitic	Glossic Udic Natriborolls	Mollisols.
Arveson	Coarse-loamy, frigid	Typic Calciaquolls	Mollisols.
Arvilla	Sandy, mixed	Udic Haploborolls	Mollisols.
Bearden	Fine-silty, frigid	Aeric Calciaquolls	Mollisols.
Benoit	Fine-loamy over sandy or sandy-skeletal, frigid	Typic Calciaquolls	Mollisols.
Beotia	Fine-silty, mixed	Pachic Udic Haploborolls	Mollisols.
Buse	Fine-loamy, mixed	Udorthentic Haploborolls	Mollisols.
Colvin	Fine-silty, frigid	Typic Calciaquolls	Mollisols.
Divide	Fine-loamy over sandy or sandy-skeletal, frigid	Aeric Calciaquolls	Mollisols.
Dovray	Fine, montmorillonitic, frigid	Cumulic Haplaquolls	Mollisols.
Edgeley	Fine-loamy, mixed	Udic Haploborolls	Mollisols.
Embden	Coarse-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Estelline	Fine-silty over sandy or sandy-skeletal, mixed	Pachic Udic Haploborolls	Mollisols.
Exline	Fine, montmorillonitic	Leptic Natriborolls	Mollisols.
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed	Pachic Udic Haploborolls	Mollisols.
Forman	Fine-loamy, mixed	Udic Argiborolls	Mollisols.
Great Bend	Fine-silty, mixed	Udic Haploborolls	Mollisols.
Hamar	Sandy, mixed, frigid	Typic Haplaquolls	Mollisols.
Hamerly	Fine-loamy, frigid	Aeric Calciaquolls	Mollisols.
Harmony	Fine, montmorillonitic	Pachic Udic Argiborolls	Mollisols.
Hecla	Sandy, mixed	Pachic Udic Haploborolls	Mollisols.
Kloten	Loamy, mixed	Lithic Haploborolls	Mollisols.
Kranzburg	Fine-silty, mixed	Udic Haploborolls	Mollisols.
Lamoure	Fine-silty, mixed (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Larson	Fine-loamy, mixed	Udic Natriborolls	Mollisols.
Ludden	Fine, montmorillonitic (calcareous), frigid	Vertic Haplaquolls	Mollisols.
Maddock	Sandy, mixed	Udorthentic Haploborolls	Mollisols.
Oldham	Fine, montmorillonitic (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Parnell	Fine, montmorillonitic, frigid	Typic Argiaquolls	Mollisols.
Peever	Fine, montmorillonitic	Udic Argiborolls	Mollisols.
Playmoor	Fine-silty, mixed (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Poinsett	Fine-silty, mixed	Udic Haploborolls	Mollisols.
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed	Udic Haploborolls	Mollisols.
Serden	Mixed, frigid	Typic Udipsamments	Entisols.
Sieche	Fine, mixed	Pachic Udic Argiborolls	Mollisols.
Sinai	Fine, montmorillonitic	Pachic Udic Haploborolls	Mollisols.
Sioux	Sandy-skeletal, mixed	Udorthentic Haploborolls	Mollisols.
Stirum	Coarse-loamy, mixed, frigid	Typic Natraquolls	Mollisols.
Swenoda	Coarse-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Tonka	Fine, montmorillonitic, frigid	Argiaquic Argialbolls	Mollisols.
Ulen	Sandy, mixed	Aeric Calciaquolls	Mollisols.
Vallers	Fine-loamy, frigid	Typic Calciaquolls	Mollisols.
Venlo	Sandy, mixed, frigid	Typic Haplaquolls	Mollisols.
Waubay	Fine-silty, mixed	Pachic Udic Haploborolls	Mollisols.
Zell	Coarse-silty, mixed	Udorthentic Haploborolls	Mollisols.

ties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. As shown in table 9, the two soil orders in Marshall County are Entisols and Mollisols.

Entisols are light-colored soils that do not have natural genetic horizons or that have only very weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Mollisols have formed under grass and have a thick, dark-colored surface layer containing colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

SUBORDERS.—Each order has been subdivided into suborders, primarily on the basis of the characteristics that seemed to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUPS.—Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 9 because it is the last word in the name of the subgroup.

SUBGROUPS.—Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

FAMILIES.—Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

General Nature of the County

Marshall County was created in 1885 when a special act of the Dakota Territorial Legislature separated it from Day County. The county was named for Governor William Marshall of Minnesota, an early settler in the county area. Britton, founded in 1884, was chosen for the county seat.

An infantry and cavalry post, originally called Fort Wadsworth and later called Fort Sisseton, was established in the south-central part of the county in 1864. It became known as a social center for northeastern Dakota, and many times during the early days the settlers sought refuge within its walls. Although a few buildings are now missing, Fort Sisseton is much like it was originally. It is the oldest fort still in existence in South Dakota. In 1959 Fort Sisseton was made a State park.

A part of the former Sisseton-Wahpeton Indian Reservation, originally called the Lake Traverse Reserve, is in the eastern part of the county. It was created by treaty in 1867, and confirmed by an act of Congress in 1874, as the home of the Sisseton and Wahpeton tribes of the Sioux Indians. Then, in 1891, because the white man endeavored to obtain homesteads, the U.S. Government entered into an agreement with the Indians in which each tribe member selected an allotment of 160 acres. The remaining land was purchased in cash by the U.S. Government and was opened for settlement in 1892.

According to the U.S. Census of Population, Marshall County had 4,544 people in 1890. The population continued to grow to a high of 9,596 in 1920. It decreased steadily after 1920 to 8,880 in 1940 and 6,663 in 1960. Britton, the county's largest town, has a population of about 1,440.

Two railroads serve this county, the Chicago, Milwaukee, St. Paul, and Pacific Railroad and the Burlington Northern. State Routes 10, 23, and 25 are the main thoroughfares. Britton has a municipal airport.

In the western part of the county, in the glacial Lake Dakota area, water wells tap either a deep artesian aquifer or shallower ground water. The artesian water is highly mineralized, mainly with sodium sulfate. The shallower wells differ widely in content of dissolved minerals. Also, the underlying material is too fine grained in places to yield water freely. Well water in this western area is generally unsuitable for irrigation. Fair to good quality ground water is available in the eastern part of the county. Wild Rice and Crow Creeks, the two main streams of the county, have little or no flow in summer except after heavy rains.

Climate [11]

Marshall County has a continental climate that is characterized by cold winters, hot summers, and little winter precipitation. Rainfall in the growing season is adequate to marginal for adapted crops. Numerous small lakes in the southeastern part of the county have a small effect on the climate in their immediate vicinity, and elsewhere the climate is not affected by bodies of water or other physical features.

Table 10 lists temperature and precipitation data representative of Marshall County. Table 11 gives the probability of specified temperatures after certain dates in spring and before certain dates in fall.

The climatic data for this county are based on 55 years (period of 1913–67) of weather observations at Britton,

[11] By WALTER SPUHLER, climatologist for South Dakota, National Weather Service, U.S. Department of Commerce.

TABLE 10.—*Temperature and precipitation data*

[Data from Britton, period of record 1913–67. Prepared by Professor WILLIAM F. LYTLE, South Dakota State University]

Month	Temperature				Precipitation							
	Average daily maximum	Average daily minimum	Two years in 10 will have—		Average total	Record		One year in 10 will have—		Average total snowfall	Average number of days that have—	
			Average maximum equal to or higher than—	Average minimum equal to or lower than—		Maximum total	Minimum total	Less than—	More than—		Snowfall of 1 inch or more	Snow depth of 1 inch or more
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Inches	Inches	Inches		
January	20.3	−1.0	29.8	−10.6	0.43	2.65	0.02	0.07	0.95	4.5	2	15
February	24.9	3.9	34.1	−6.1	.54	2.92	.02	.08	1.21	5.3	2	13
March	38.0	17.6	45.4	11.1	.62	2.13	.03	.13	1.29	3.4	1	6
April	56.1	32.0	62.4	27.2	1.85	4.90	.12	.49	3.60	1.9	1	1
May	68.9	43.5	75.0	38.8	2.53	7.96	.04	.71	4.86	.1	0	0
June	77.5	53.7	83.1	49.6	3.96	9.73	.42	1.62	6.77	0	0	0
July	84.9	59.2	90.2	55.2	2.54	7.25	.32	.85	4.64	0	0	0
August	83.7	56.9	88.5	52.8	2.66	10.22	.44	.80	5.03	0	0	0
September	73.1	46.9	78.7	43.0	1.88	6.66	0	.49	3.78	0	0	0
October	60.7	35.0	67.5	29.9	1.15	4.23	0	.19	2.54	.7	0	0
November	40.3	19.8	47.2	14.0	.67	3.08	.02	.10	1.50	3.0	1	4
December	26.2	6.1	34.1	−2.0	.41	1.50	0	.09	.88	3.7	2	12
Year	54.6	31.2	57.1	28.9	19.24	[1] 35.79	[2] 11.46	13.93	25.22	22.6	9	52

[1] 1916.
[2] 1952.

which is in the west-central part of the county and has an elevation of 1340 feet. Climatic conditions at Britton are representative of those throughout the county. The mean annual precipitation throughout the county is expected to be within 1 inch of that at Britton. The mean annual temperature throughout the county is expected to be within 1 degree of that at Britton.

Temperature has a large seasonal variation and occasionally a large change from day to day. Temperatures have risen to above 100° F. in summer and fallen to −30° F. in winter. The temperature can be expected to exceed 100° about 3 days per year and to fall to −30° about one day per year. About 8 days per year can be expected to have a temperature of −20°. Minimal temperatures (0° or less) can be expected about 42 days per year. The daily high does not exceed 0° about 7 days per year.

Table 11 lists the probabilities of selected temperatures in spring and in fall. The lower half of the table shows that 3 years in 10 a temperature of 32 degrees or less will occur by September 5. This should be interpreted as indicating that there is a 30 percent chance that it will be 32° or less at Britton on or before this date. These data are derived from observations made in a standard

TABLE 11.—*Probabilities of selected temperatures after specified dates in spring and before specified dates in fall*

[All data from Britton. Period of record 1913–67. Prepared by Professor WILLIAM F. LYTLE, South Dakota State University]

Probability	Dates for given probability and temperature					
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower
Spring:						
9 years in 10 later than	March 15	March 27	April 5	April 20	May 1	May 9
7 years in 10 later than	March 23	April 3	April 13	April 26	May 7	May 16
5 years in 10 later than	April 6	April 16	April 27	May 7	May 18	May 29
3 years in 10 later than	April 19	April 29	May 10	May 18	May 28	June 10
1 year in 10 later than	April 28	May 6	May 19	May 25	June 3	June 17
Fall:						
1 year in 10 earlier than	September 25	September 17	September 11	September 5	August 29	August 18
3 years in 10 earlier than	October 7	September 29	September 21	September 14	September 5	August 26
5 years in 10 earlier than	October 27	October 19	October 8	September 29	September 18	September 9
7 years in 10 earlier than	November 16	November 8	October 25	October 14	September 30	September 22
9 years in 10 earlier than	November 28	November 20	November 4	October 23	October 8	September 30

instrument shelter. Plant temperatures may vary somewhat from the temperature of the free air.

The average annual precipitation at Britton is 19.24 inches, of which 15.42 inches, or 80 percent, falls in the growing season of April through September. During the 54 years that data were taken, the annual precipitation has ranged from 11.46 inches in 1952 to 35.59 inches in 1916. Thunderstorms are the main source of rainfall during the growing season. The rainfall during these storms varies widely in intensity and amount. Rainfall of 1.2 inches in 1 hour occurs about once a year and rainfall of 2 inches in 1 hour about once in 5 years. A 24-hour rainfall of 2 inches occurs about once in 2 years and a 24-hour rainfall of 3 inches about once in 10 years.

Snow cover effectively protects pasture and fall-seeded grains, but it may hinder farm operations. About 40 inches of snow falls each year. Strong winds often accompany a snowfall, causing large drifts to form in or near sheltered areas and leaving open fields nearly bare. Snow cover of 1 inch or more occurs about 75 days per year.

Sunshine, wind, and relative humidity for the county are estimated from data obtained at Huron and Sioux Falls, South Dakota, and Fargo, North Dakota. An average year has sunshine about 65 percent of the daylight hours. In July, the sunniest month, about 75 percent of the daylight hours have sunshine. The winter months have the lowest percentage, and December has less than 50 percent sunshine during the normal daylight hours.

Southerly winds of about 11 miles per hour prevail in summer. In winter the prevailing northwesterly winds average 12 to 13 miles per hour.

Water loss by soil and crops is indicated by evaporation from a large pan. The average annual evaporation from a Weather Bureau Class A pan is about 47 inches. About 39 inches evaporates in the period May through October. Pan evaporation represents the maximum or potential evaporation. The actual water loss from soil is commonly less, because the moisture supply of the soil is often limited. Small-lake evaporation averages about 72 percent of that of the pan.

Relative humidity averages about 65 percent in the afternoon and 80 percent in the morning during winter. In summer it averages about 50 percent in the afternoon and 75 percent in the morning.

Farming

Before 1900 only a few of the settlers depended on farming for a livelihood. Many of them were speculators and tradesmen, but some were farmers who found livestock raising profitable. Prices of livestock declined after the turn of the century, and farmers began to raise small grains. Today a combination of grain farming, livestock raising, dairying, and poultry production makes up the county's farm enterprises.

Farming is the main occupation in the county. According to the U.S. Census of Agriculture, there were 716 farms in the county in 1969. Of these, 135 were 1,000 acres or more in size and 86 were less than 180 acres. Farms in Marshall County are increasing in size, and in 1969 the average size was 698 acres. The majority of the 716 farms reported were classified as livestock farms and ranches. The remainder are cash-grain farms, general farms, dairy farms, poultry farms, and miscellaneous and unclassified farms. Owners or part owners operate most of the farms in the county. Tenants operate about 16 percent of them. Of the county's total area, 92 percent was in farms in 1969.

Livestock in the county in 1969 included 77,179 cattle and calves on 533 farms and ranches, 19,187 hogs and pigs on 343 farms, 19,680 sheep and lambs on 110 farms, and 19,518 chickens on 128 farms.

Generally the cattle population of the county has increased over the years. The number of hogs, however, has shown considerable variation because production can be quickly increased or decreased, depending on changes in market conditions and feed supplies.

The major crops are spring and durum wheat, barley, flax, rye, oats, corn, millet, alfalfa, and wild hay. According to the 1964 census, spring wheat was harvested from 39,901 acres, durum wheat from 7,345 acres, barley from 11,491 acres, flaxseed from 21,539 acres, rye from 5,444 acres, oats from 31,376 acres, corn for grain from 33,382 acres, corn cut for silage from 13,745 acres, and millet from 6,711 acres. Alfalfa or an alfalfa mixture for hay and dehydration was cut from 32,965 acres. Native grass cut for wild hay totaled 50,807 acres. Small acreages were in sorghum and soybeans.

About 59 percent of the cash-farm income in Marshall County came from livestock products in the period 1960–64. Field crops, including hay, contributed about 29 percent.

Information about the past history of cropping and livestock raising in Marshall County can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service (*8*).

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but that in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Buffer strips. Relatively narrow bands of tall-growing and annual crops or perennial vegetation grown specifically for erosion control. Corn is the main crop used for buffer strips for wind erosion control. Most buffers are used in conjunction with fallow where stripcropping or windbreaks are not used. Buffer strips are effective for erosion control, and they trap and spread snow over the field.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Contour stripcropping. Growing crops in strips that follow the contour or are parallel to terraces or diversions. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Coulee. A timbered, steeply sloping, trenchlike valley.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Crop residue management. A system of retaining crop residue on land between harvest and replanting to prevent erosion and insure future crop production.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Eolian lacustrine sand. Soil material accumulated through wind action from water-laid sediment.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, and sand, and boulders transported and deposited by glacial ice.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Minimum tillage. The least amount of tillage required for quick germination and a good stand. Several implements may be drawn behind the tractor to reduce the number of times it is driven over the field, but it does not imply that primary tillage, secondary tillage, fertilization, and seeding must be done in one trip across the field.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Rotation grazing. Grazing two or more pastures, or parts of a range, in regular order, with definite recovery periods between grazing periods. Contrasts with continuous grazing.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Windbreak. Any shelter that protects from the wind. A vegetative windbreak is a strip of closely spaced trees or shrubs that is planted primarily to deflect wind currents and thereby reduce soil blowing, control snow drifting, conserve moisture, and protect crops, orchards, livestock, and buildings.

Wind stripcropping. Growing crops in strips that run crosswise to the general direction of prevailing wind and without strict adherence to the contour of the land.

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GUIDE TO MAPPING UNITS

Absence of a capability unit, pasture group, range site, or windbreak group designation indicates that the mapping unit was not placed in the specified grouping. For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Other information is given in tables as follows:

Acreage and extent, table 1, page 12.
Estimated yields, table 2, page 63.
Recreation, table 4, page 75.
Engineering uses of the soils, table 5, page 80; table 6, page 88; table 7, page 102; and table 8, page 104.

Map symbol	Mapping unit	Described on page	Capability unit: Symbol	Capability unit: Page	Pasture group: Letter	Range site: Name	Windbreak group: Number
AaA	Aastad loam, 0 to 2 percent slopes	11	IIc-3	57	K	Overflow	1
AbA	Aberdeen-Exline silty clay loams, 0 to 2 percent slopes	13	IIIs-1	58	------	----------	------
	Aberdeen part	--	--------	--	E	Clayey	4
	Exline part	--	--------	--	------	Thin Claypan	10
Ar	Arveson fine sandy loam	14	Vw-1	60	B	Subirrigated	10
AsE	Arvilla-Sioux loams, 9 to 25 percent slopes	15	VIe-6	61	------	----------	10
	Arvilla part	--	--------	--	D	Shallow to Gravel	--
	Sioux part	--	--------	--	------	Very Shallow	--
Ba	Bearden silt loam	15	IIe-4	55	F	Silty	1
BdA	Bearden-Tonka silt loams, 0 to 3 percent slopes	16	IIw-1	56	------	----------	------
	Bearden part	--	--------	--	F	Silty	1
	Tonka part	--	--------	--	A	Closed Depression	10
Be	Benoit and Divide loams	16	--------	--	------	----------	------
	Benoit part	--	Vw-1	60	B	Wet Land	10
	Divide part	--	IIIs-4	59	A	Silty	2
BfA	Beotia silt loam, 0 to 2 percent slopes	17	IIc-3	57	K	Silty	3
BfB	Beotia silt loam, 2 to 6 percent slopes	17	IIe-3	55	K	Silty	3
BhA	Beotia-Bearden silt loams, 0 to 3 percent slopes	17	IIe-4	55	------	Silty	------
	Beotia part	--	--------	--	K	----------	3
	Bearden part	--	--------	--	F	----------	1
BkE	Buse-Forman loams, 9 to 21 percent slopes	18	VIe-3	61	------	----------	------
	Buse part	--	--------	--	G	Thin Upland	10
	Forman part	--	--------	--	F	Silty	3
BkF	Buse-Forman loams, 21 to 40 percent slopes	19	VIIe-3	62	------	----------	10
	Buse part	--	--------	--	------	Thin Upland	------
	Forman part	--	--------	--	------	Silty	------
BmF	Buse-Forman stony complex, 9 to 40 percent slopes	19	VIIs-6	62	------	----------	10
	Buse part	--	--------	--	------	Thin Upland	------
	Forman part	--	--------	--	------	Silty	------
BsE	Buse-Sioux complex, 15 to 21 percent slopes	19	VIe-3	61	------	----------	10
	Buse part	--	--------	--	G	Thin Upland	------
	Sioux part	--	--------	--	------	Very Shallow	------
BtE	Buse-Sioux stony complex, 9 to 40 percent slopes	19	VIIs-6	62	------	----------	10
	Buse part	--	--------	--	------	Thin Upland	------
	Sioux part	--	--------	--	------	Very Shallow	------
Co	Colvin silty clay loam 1/	20	2/IIw-3	56	2/A	Subirrigated	2
			3/IVw-1	60	3/B	----------	------
Do	Dovray silty clay	21	IIw-1	56	A	Clayey	2
EdB	Edgeley loam, 2 to 6 percent slopes	22	IIe-1	55	F	Silty	6
EdC	Edgeley loam, 6 to 9 percent slopes	22	IIIe-1	57	F	Silty	6

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Letter	Name	Number
EdD	Edgeley loam, 9 to 15 percent slopes	22	IVe-1	59	F	Silty	6
EmA	Embden fine sandy loam, 0 to 2 percent slopes	23	IIIe-7	58	H	Sandy	1
EmB	Embden fine sandy loam, 2 to 6 percent slopes	23	IIIe-8	58	H	Sandy	1
EnC	Embden-Buse complex, 2 to 9 percent slopes	23	IIIe-8	58	------	----------	------
	Embden part	--	--------	--	H	Sandy	1
	Buse part	--	--------	--	G	Thin Upland	8
EsA	Estelline silt loam, 0 to 2 percent slopes	23	IIIs-2	59	D	Silty	6
ExA	Exline-Aberdeen silty clay loams, 0 to 2 percent slopes	24	VIs-1	61	------	----------	------
	Exline part	--	--------	--	------	Thin Claypan	10
	Aberdeen part	--	--------	--	E	Clayey	4
FoA	Fordville loam, 0 to 2 percent slopes	25	IIIs-2	59	D	Silty	6
FoB	Fordville loam, 2 to 6 percent slopes	25	IIIe-6	57	D	Silty	6
FrA	Forman-Aastad loams, 0 to 2 percent slopes	26	IIc-2	56	------	----------	------
	Forman part	--	--------	--	F	Silty	3
	Aastad part	--	--------	--	K	Overflow	1
FrB	Forman-Aastad loams, 2 to 6 percent slopes	26	IIe-2	55	------	Silty	------
	Forman part	--	--------	--	F	----------	3
	Aastad part	--	--------	--	K	----------	1
FrC	Forman-Aastad loams, 6 to 9 percent slopes	27	IIIe-2	57	------	Silty	------
	Forman part	--	--------	--	F	----------	3
	Aastad part	--	--------	--	K	----------	1
FrD	Forman-Aastad loams, 9 to 15 percent slopes	27	IVe-1	59	------	Silty	------
	Forman part	--	--------	--	F	----------	3
	Aastad part	--	--------	--	K	----------	1
FsC2	Forman-Buse loams, 6 to 9 percent slopes, eroded	27	IVe-1	59	------	----------	------
	Forman part	--	--------	--	F	Silty	3
	Buse part	--	--------	--	G	Thin Upland	10
FsE	Forman-Buse loams, 15 to 25 percent slopes	28	VIe-1	61	------	----------	10
	Forman part	--	--------	--	F	Silty	------
	Buse part	--	--------	--	G	Thin Upland	------
FtD	Forman-Buse stony complex, 6 to 21 percent slopes	28	VIIs-6	62	------	----------	10
	Forman part	--	--------	--	------	Silty	------
	Buse part	--	--------	--	------	Thin Upland	------
FxC	Forman-Poinsett complex, 6 to 9 percent slopes	28	IIIe-2	57	F	Silty	3
FxD	Forman-Poinsett complex, 9 to 15 percent slopes	28	IVe-1	59	F	Silty	3
GbB	Great Bend silt loam, 2 to 6 percent slopes	29	IIe-1	55	F	Silty	3
GdA	Great Bend-Beotia silt loams, 0 to 2 percent slopes	29	IIc-2	56	------	Silty	3
	Great Bend part	--	--------	--	F	----------	------
	Beotia part	--	--------	--	K	----------	------
GeB	Great Bend-Zell silt loams, 2 to 6 percent slopes	29	IIe-1	55	------	----------	------
	Great Bend part	--	--------	--	F	Silty	3
	Zell part	--	--------	--	G	Thin Upland	8

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Letter	Name	Number
GeC	Great Bend-Zell silt loams, 6 to 9 percent slopes	30	IIIe-1	57	------	----------	------
	Great Bend part	--	--------	--	F	Silty	3
	Zell part	--	--------	--	G	Thin Upland	8
Ha	Hamar loamy fine sand	30	IVw-2	60	A	Subirrigated	2
Hd	Hamar fine sandy loam	30	IIIw-5	58	A	Subirrigated	2
HeA	Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes	32	IIs-1	56	E	Clayey	4
HfA	Hecla loamy fine sand, 0 to 3 percent slopes	32	IVe-9	60	H	Sands	2
HhA	Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	32	IVe-9	60	------	----------	2
	Hecla part	--	--------	--	H	Sands	------
	Hamar part	--	--------	--	A	Subirrigated	------
HvB2	Hecla-Venlo complex, 0 to 6 percent slopes, eroded	32	VIe-7	61	------	----------	------
	Hecla part	--	--------	--	H	Sands	2
	Venlo part	--	--------	--	B	Wet Land	10
KbE	Kloten-Buse complex, 15 to 40 percent slopes	33	VIIe-3	62	------	Thin Upland	10
KnA	Kranzburg silt loam, 0 to 2 percent slopes	34	IIc-2	56	F	Silty	3
KnB	Kranzburg silt loam, 2 to 6 percent slopes	34	IIe-1	55	F	Silty	3
KnC2	Kranzburg silt loam, 6 to 9 percent slopes, eroded	34	IVe-1	59	F	Silty	3
KrA	Kranzburg-Aberdeen silt loams, 0 to 2 percent slopes	34	IIc-2	56	------	----------	------
	Kranzburg part	--	--------	--	F	Silty	3
	Aberdeen part	--	--------	--	E	Clayey	4
KrB	Kranzburg-Aberdeen silt loams, 2 to 6 percent slopes	34	IIe-1	55	------	----------	------
	Kranzburg part	--	--------	--	F	Silty	3
	Aberdeen part	--	--------	--	E	Clayey	4
La	Lamoure silty clay loam 1/	35	2/IIw-2	56	2/A	Subirrigated	2
			3/IVw-1	60	3/B	----------	------
Lo	Loamy alluvial land	36	VIw-3	61	------	Overflow	10
Lu	Ludden silty clay 1/	36	2/IIw-2	56	2/A	Overflow	10
			3/IVw-1	60	3/B	----------	------
MaB	Maddock loamy fine sand, 2 to 6 percent slopes	37	IVe-9	60	H	Sands	7
MaD	Maddock loamy fine sand, 6 to 15 percent slopes	37	VIe-7	61	H	Sands	10
Mr	Marsh	37	VIIIw-1	62	------	----------	------
Od	Oldham silty clay loam 1/	38	2/IIw-3	56	2/A	Overflow	2
			3/IVw-1	60	3/B	----------	------
Oh	Oldham silty clay loam, saline	38	IVw-1	60	J	Wet Land	10
Pa	Parnell silty clay loam 1/	38	2/IIIw-2	58	2/A	Wet Land	10
			3/Vw-4	60	3/B	----------	------
PeA	Peever clay loam, 0 to 2 percent slopes	39	IIs-1	56	E	Clayey	4
PeB	Peever clay loam, 2 to 6 percent slopes	39	IIIe-3	57	E	Clayey	4
PeC	Peever clay loam, 6 to 9 percent slopes	40	IVe-7	59	E	Clayey	4
PhA	Peever-Hamerly complex, 0 to 2 percent slopes	40	IIe-4	55	------	----------	------
	Peever part	--	--------	--	E	Clayey	4
	Hamerly part	--	--------	--	F	Silty	1
Pm	Playmoor silty clay loam	40	IVw-1	60	J	Subirrigated	10
PoB	Poinsett-Forman complex, 2 to 6 percent slopes	41	IIe-2	55	F	Silty	3

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Letter	Name	Number
PwA	Poinsett-Waubay silty clay loams, 0 to 2 percent slopes	41	IIc-3	57	------	Silty	------
	Poinsett part	--	--------	--	F	----------	3
	Waubay part	--	--------	--	K	----------	1
PwB	Poinsett-Waubay silty clay loams, 2 to 6 percent slopes	42	IIe-1	55	------	Silty	------
	Poinsett part	--	--------	--	F	----------	3
	Waubay part	--	--------	--	K	----------	1
RfA	Renshaw-Fordville loams, 0 to 3 percent slopes	42	IVs-1	60	D	----------	------
	Renshaw part	--	--------	--	------	Shallow to Gravel	10
	Fordville part	--	--------	--	------	Silty	6
RfB	Renshaw-Fordville loams, 3 to 6 percent slopes	43	IVe-6	59	D	----------	------
	Renshaw part	--	--------	--	------	Shallow to Gravel	10
	Fordville part	--	--------	--	------	Silty	6
RfC	Renshaw-Fordville loams, 6 to 9 percent slopes	43	VIe-5	61	D	----------	------
	Renshaw part	--	--------	--	------	Shallow to Gravel	10
	Fordville part	--	--------	--	------	Silty	6
Sa	Sandy lake beaches	43	VIw-3	61	------	Subirrigated	10
SdD2	Serden fine sand, 6 to 21 percent slopes, eroded	44	VIe-7	61	------	Sands	10
SeB	Serden-Venlo complex, 0 to 6 percent slopes	44	VIe-7	61	------	----------	10
	Serden part	--	--------	--	------	Sands	------
	Venlo part	--	--------	--	B	Wet Land	------
ShD	Sieche loam, 6 to 15 percent slopes	45	IVe-1	59	F	----------	4
ShF	Sieche loam, 21 to 50 percent slopes	45	VIIe-1	61	------	----------	10
SkA	Sinai silty clay, 0 to 3 percent slopes	46	IIs-1	56	I	Clayey	4
SkB	Sinai silty clay, 3 to 6 percent slopes	46	IIIe-3	57	I	Clayey	4
SkC	Sinai silty clay, 6 to 9 percent slopes	46	IVe-7	59	I	Clayey	4
SmE	Sioux-Arvilla loams, 15 to 40 percent slopes	47	VIIs-4	62	------	----------	10
	Sioux part	--	--------	--	------	Very Shallow	------
	Arvilla part	--	--------	--	------	Shallow to Gravel	------
Su	Stirum-Ulen fine sandy loams	48	IVw-2	60	------	----------	------
	Stirum part	--	--------	--	C	Subirrigated	9
	Ulen part	--	--------	--	H	Sandy	2
SwA	Swenoda fine sandy loam, 0 to 2 percent slopes	48	IIIe-7	58	H	Sandy	1
SwB	Swenoda fine sandy loam, 2 to 6 percent slopes	48	IIIe-8	58	H	Sandy	1
SxA	Swenoda-Larson complex, 0 to 2 percent slopes	49	IIIe-7	58	------	----------	------
	Swenoda part	--	--------	--	H	Sandy	1
	Larson part	--	---------	--	C	Claypan	9
To	Tonka silt loam 1/	49	2/IIw-1	56	2/A	Closed Depression	10
			3/IVw-1	60	3/B	----------	------
Uf	Ulen fine sandy loam	50	IIIe-14	58	H	Sandy	2
Us	Ulen-Stirum fine sandy loams	50	IIIe-14	58	------	----------	------
	Ulen part	--	--------	--	H	Sandy	2
	Stirum part	--	--------	--	C	Subirrigated	9
Va	Vallers loam 1/	51	2/IIw-3	56	2/A	Subirrigated	2
			3/IVw-1	60	3/B	----------	------
Wa	Wet alluvial land	52	Vw-4	60	------	Wet Land	10

1/Status of artificial drainage and feasibility of drainage determined by onsite inspection.

2/Drained.
3/Undrained.

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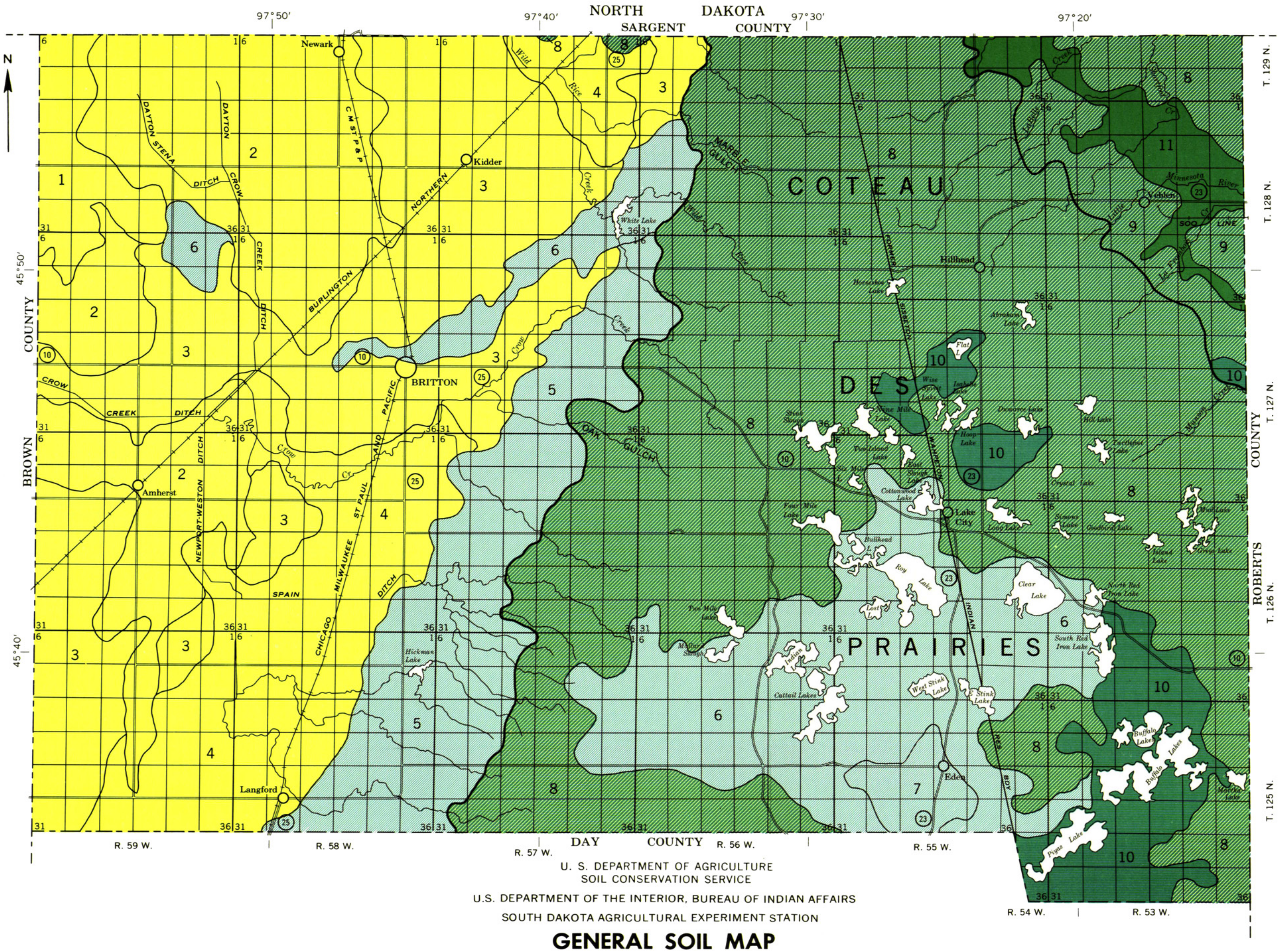


SOIL ASSOCIATIONS *

EXCESSIVELY DRAINED TO SOMEWHAT POORLY DRAINED SOILS FORMED MAINLY IN LACUSTRINE MATERIAL; ON GLACIAL LAKE PLAINS

1 — Maddock-Serden association: Nearly level to hilly, well-drained to excessively drained, sandy soils formed in eolian and lacustrine sand

2 — Embden-Hecla-Ulen association: Nearly level to gently undulating, well-drained to somewhat poorly drained, loamy and sandy soils formed in eolian, lacustrine, and outwash sand

3 — Beotia-Great Bend association: Nearly level to sloping, well-drained, silty soils formed in lacustrine silt

4 — Harmony-Aberdeen-Exline association: Nearly level, moderately well drained to somewhat poorly drained, silty soils formed in lacustrine silt and silty clay

WELL-DRAINED SOILS FORMED IN LOESS, GLACIAL DRIFT, AND LACUSTRINE MATERIAL; ON UPLANDS

5 — Kranzburg association: Nearly level to sloping, well-drained, silty soils formed in loess over glacial till

6 — Forman-Poinsett association: Nearly level to rolling, well-drained, loamy and silty soils formed in glacial drift

7 — Sinai-Poinsett association: Nearly level to sloping, well-drained, clayey and silty soils formed in lacustrine sediment and glacial drift

WELL-DRAINED TO POORLY DRAINED SOILS FORMED IN GLACIAL TILL; ON UPLANDS

8 — Forman-Aastad-Buse association: Nearly level to steep, well drained and moderately well drained, loamy soils formed in glacial till

9 — Peever-Forman-Tonka association: Nearly level to sloping, well-drained, loamy soils formed in glacial till and level, poorly drained, silty soils formed in alluvium from adjacent uplands

WELL-DRAINED TO EXCESSIVELY DRAINED SOILS FORMED IN GLACIAL OUTWASH; ON UPLANDS

10 — Renshaw-Fordville-Sioux association: Nearly level to steep, well-drained to excessively drained, loamy soils underlain by sand and gravel

SOMEWHAT POORLY DRAINED TO POORLY DRAINED SOILS FORMED IN ALLUVIUM; ON BOTTOM LANDS

11 — Dovray-Ludden-Lamoure association: Level and nearly level, poorly drained to somewhat poorly drained, clayey and silty soils formed in alluvium

* Texture named in soil associations is that of surface layer.

Compiled 1973

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

MARSHALL COUNTY, SOUTH DAKOTA

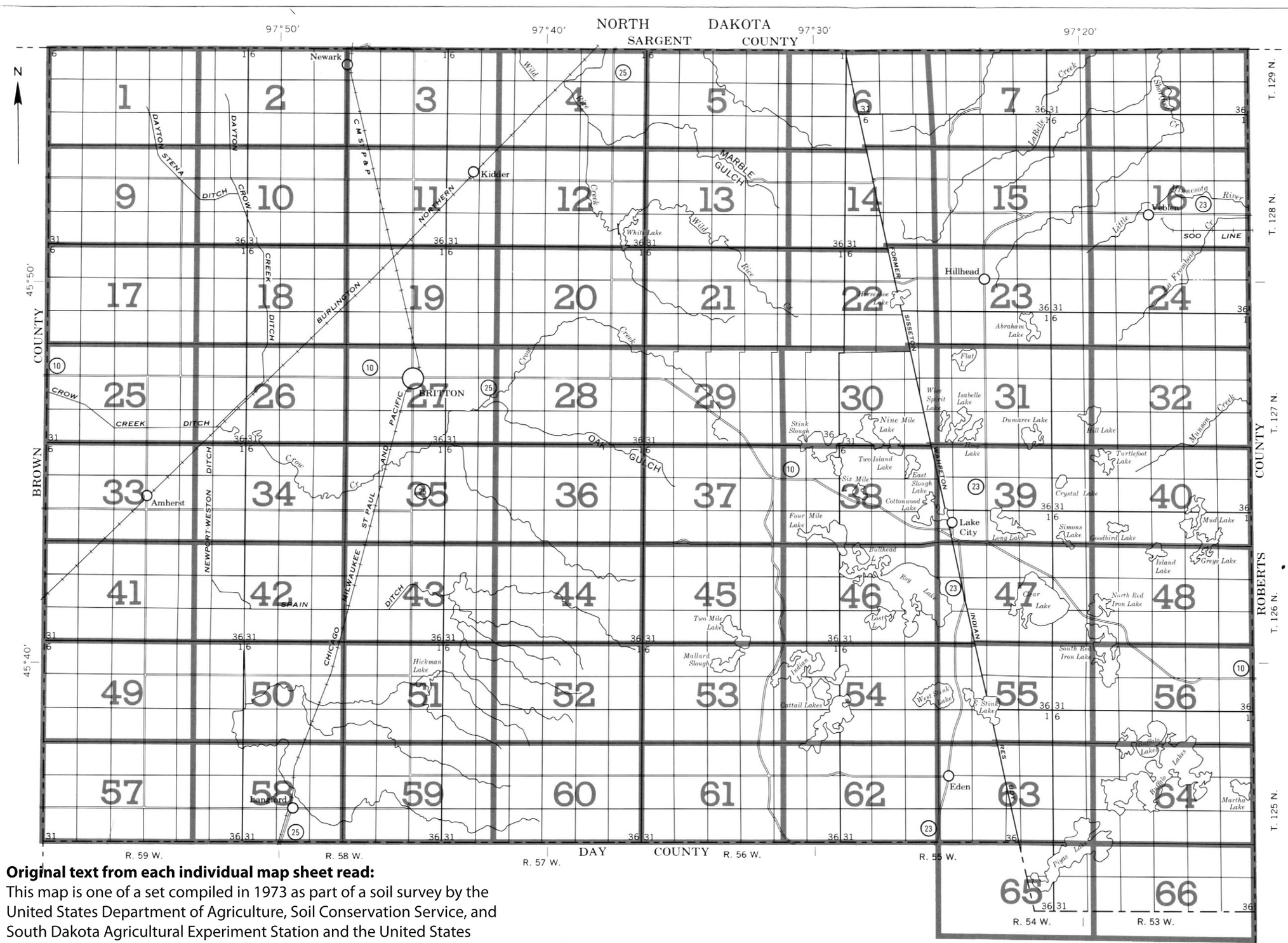
Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Original text from each individual map sheet read:
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and South Dakota Agricultural Experiment Station and the United States Department of Interior, Bureau of Indian Affairs. Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the South Dakota coordinate system, North Zone. Land division corners are approximately positioned on this map.

INDEX TO MAP SHEETS

MARSHALL COUNTY, SOUTH DAKOTA

Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
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30	29	28	27	26	25
31	32	33	34	35	36

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SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Symbols without a slope letter are those of nearly level soils. A final number, 2, in the symbol shows that the soil is eroded.

SYMBOL	NAME
AgA	Aastad loam, 0 to 2 percent slopes
AbA	Aberdeen-Exline silty clay loams, 0 to 2 percent slopes
Ar	Arveson fine sandy loam
AsE	Arvilla-Sioux loams, 9 to 25 percent slopes
Ba	Bearden silt loam
BdA	Bearden-Tonka silt loams, 0 to 3 percent slopes
Be	Benoit and Divide loams
BfA	Beotia silt loam, 0 to 2 percent slopes
BfB	Beotia silt loam, 2 to 6 percent slopes
BhA	Beotia-Bearden silt loams, 0 to 3 percent slopes
BkE	Buse-Forman loams, 9 to 21 percent slopes
BkF	Buse-Forman loams, 21 to 40 percent slopes
BmF	Buse-Forman stony complex, 9 to 40 percent slopes
BsE	Buse-Sioux complex, 15 to 21 percent slopes
BtE	Buse-Sioux stony complex, 9 to 40 percent slopes
Co	Colvin silty clay loam
Do	Dovray silty clay
EdB	Edgeley loam, 2 to 6 percent slopes
EdC	Edgeley loam, 6 to 9 percent slopes
EdD	Edgeley loam, 9 to 15 percent slopes
EmA	Embden fine sandy loam, 0 to 2 percent slopes
EmB	Embden fine sandy loam, 2 to 6 percent slopes
EnC	Embden-Buse complex, 2 to 9 percent slopes
EsA	Estelline silt loam, 0 to 2 percent slopes
ExA	Exline-Aberdeen silty clay loams, 0 to 2 percent slopes
FoA	Fordville loam, 0 to 2 percent slopes
FoB	Fordville loam, 2 to 6 percent slopes
FrA	Forman-Aastad loams, 0 to 2 percent slopes
FrB	Forman-Aastad loams, 2 to 6 percent slopes
FrC	Forman-Aastad loams, 6 to 9 percent slopes
FrD	Forman-Aastad loams, 9 to 15 percent slopes
FsC2	Forman-Buse loams, 6 to 9 percent slopes, eroded
FsE	Forman-Buse loams, 15 to 25 percent slopes
FtD	Forman-Buse stony complex, 6 to 21 percent slopes
FxC	Forman-Poinsett complex, 6 to 9 percent slopes
FxD	Forman-Poinsett complex, 9 to 15 percent slopes
GbB	Great Bend silt loam, 2 to 6 percent slopes
GdA	Great Bend-Beotia silt loams, 0 to 2 percent slopes
GeB	Great Bend-Zell silt loams, 2 to 6 percent slopes
GeC	Great Bend-Zell silt loams, 6 to 9 percent slopes
Ha	Hamar loamy fine sand
Hd	Hamar fine sandy loam
HeA	Harmony-Aberdeen silty clay loams, 0 to 2 percent slopes
HfA	Hecla loamy fine sand, 0 to 3 percent slopes
HhA	Hecla-Hamar loamy fine sands, 0 to 3 percent slopes
HvB2	Hecla-Venlo complex, 0 to 6 percent slopes, eroded
KbE	Kloten-Buse complex, 15 to 40 percent slopes
KnA	Kranzburg silt loam, 0 to 2 percent slopes
KnB	Kranzburg silt loam, 2 to 6 percent slopes
KnC2	Kranzburg silt loam, 6 to 9 percent slopes, eroded
KrA	Kranzburg-Aberdeen silt loams, 0 to 2 percent slopes
KrB	Kranzburg-Aberdeen silt loams, 2 to 6 percent slopes
La	Lamoure silty clay loam
Lo	Loamy alluvial land
Lu	Ludden silty clay
MaB	Maddock loamy fine sand, 2 to 6 percent slopes
MaD	Maddock loamy fine sand, 6 to 15 percent slopes
Mr	Marsh
Od	Oldham silty clay loam
Oh	Oldham silty clay loam, saline
Pa	Parnell silty clay loam
PeA	Peever clay loam, 0 to 2 percent slopes
PeB	Peever clay loam, 2 to 6 percent slopes
PeC	Peever clay loam, 6 to 9 percent slopes
PhA	Peever-Hamerly complex, 0 to 2 percent slopes
Pm	Playmoor silty clay loam
PoB	Poinsett-Forman complex, 2 to 6 percent slopes
PwA	Poinsett-Waubay silty clay loams, 0 to 2 percent slopes
PwB	Poinsett-Waubay silty clay loams, 2 to 6 percent slopes
RfA	Renshaw-Fordville loams, 0 to 3 percent slopes
RfB	Renshaw-Fordville loams, 3 to 6 percent slopes
RfC	Renshaw-Fordville loams, 6 to 9 percent slopes
Sa	Sandy lake beaches
SdD2	Serden fine sand, 6 to 21 percent slopes, eroded
SeB	Serden-Venlo complex, 0 to 6 percent slopes
ShD	Sieche loam, 6 to 15 percent slopes
ShF	Sieche loam, 21 to 50 percent slopes
SkA	Sinai silty clay, 0 to 3 percent slopes
SkB	Sinai silty clay, 3 to 6 percent slopes
SkC	Sinai silty clay, 6 to 9 percent slopes
SmE	Sioux-Arvilla loams, 15 to 40 percent slopes
Su	Stirum-Ulen fine sandy loams
SwA	Swenoda fine sandy loam, 0 to 2 percent slopes
SwB	Swenoda fine sandy loam, 2 to 6 percent slopes
SxA	Swenoda-Larson complex, 0 to 2 percent slopes
To	Tonka silt loam
Uf	Ulen fine sandy loam
Us	Ulen-Stirum fine sandy loams
Va	Vallers loam
Wa	Wet alluvial land

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Abandoned channel

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Well, artesian

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

MARSHALL COUNTY, SOUTH DAKOTA — SHEET NUMBER 1

2 515 000 FEET

R. 59 W.

SARGENT COUNTY NORTH DAKOTA

770 000 FEET

T. 128 N.

BROWN COUNTY

(Joins sheet 2)

(Joins sheet 9)

2 535 000 FEET

760 000 FEET

N

1 Mile 5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

DAYTON

STENA DITCH

(2)

N

R. 59 W. | R. 58 W.

SARGENT COUNTY NORTH DAKOTA

2 560 000 FEET

770 000 FEET

T. 128 N.

1 Mile

5 000 Feet

Scale 1:20 000

760 000 FEET

2 540 000 FEET

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 10)

Newark

DAYTON CREEK DITCH

DAYTON CREEK

N

2 565 000 FEET

SARGENT COUNTY NORTH DAKOTA

R. 58 W. | R. 57 W.

770 000 FEET

T. 128 N.

Newark

CHICAGO MILWAUKEE ST PAUL ANP PACIFIC

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 4)

(Joins sheet 2)

(Joins sheet 11)

760 000 FEET

2 585 000 FEET


R. 57 W.
SARGENT COUNTY NORTH DAKOTA
2 605 000 FEET
775 000 FEET
T. 128 N.
(Joins sheet 5)
(Joins sheet 3)
(Joins sheet 12)
2 590 000 FEET
760 000 FEET
Wild Rice Creek
NORTHERN
BURLINGTON
Scale 1:20 000
1 Mile
5 000 Feet

2 610 000 FEET

R. 56 W. SARGENT COUNTY NORTH DAKOTA

775 000 FEET

T. 128 N.

(Joins sheet 4)

(Joins sheet 6)

765 000 FEET

(Joins sheet 13)

2 630 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

N

R. 56 W. | R. 54 W.

SARGENT COUNTY NORTH DAKOTA

2 650 000 FEET

775 000 FEET

765 000 FEET

T. 128 N.

T. 129 N.

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 14)

2 635 000 FEET

R. 56 W. | R. 55 W.

R. 55 W. | R. 54 W.

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

N

SARGENT COUNTY NORTH DAKOTA

R. 54 W. | R. 53 W.

2 655 000 FEET

775 000 FEET

T. 129 N. | T. 128 N.

Marlow

GRAVEL PIT

LaBelle Creek

ABANDONED RAILROAD

(Joins sheet 6)

(Joins sheet 8)

(Joins sheet 15)

2 680 000 FEET

765 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

N

R. 53 W.

SARGENT COUNTY NORTH DAKOTA

2 705 000 FEET

775 000 FEET

ROBERTS COUNTY

T. 128 N. | T. 129 N.

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

765 000 FEET

(Joins sheet 7)

(Joins sheet 16)

2 685 000 FEET

Palestina Church

Shortfoot Creek

Numerous Wet Spots

Shortfoot Creek

29 28 27 26 25

32 33 34 35 36

5 4 3 2 1

N

2 515 000 FEET

R. 59 W.

(Joins sheet 1)

755 000 FEET

T. 128 N.

BROWN COUNTY

19 20 21 22 23

30 29 28 27 26

31 32 33 34 35

(Joins sheet 10)

745 000 FEET

2 535 000 FEET

(Joins sheet 17)

1 Mile

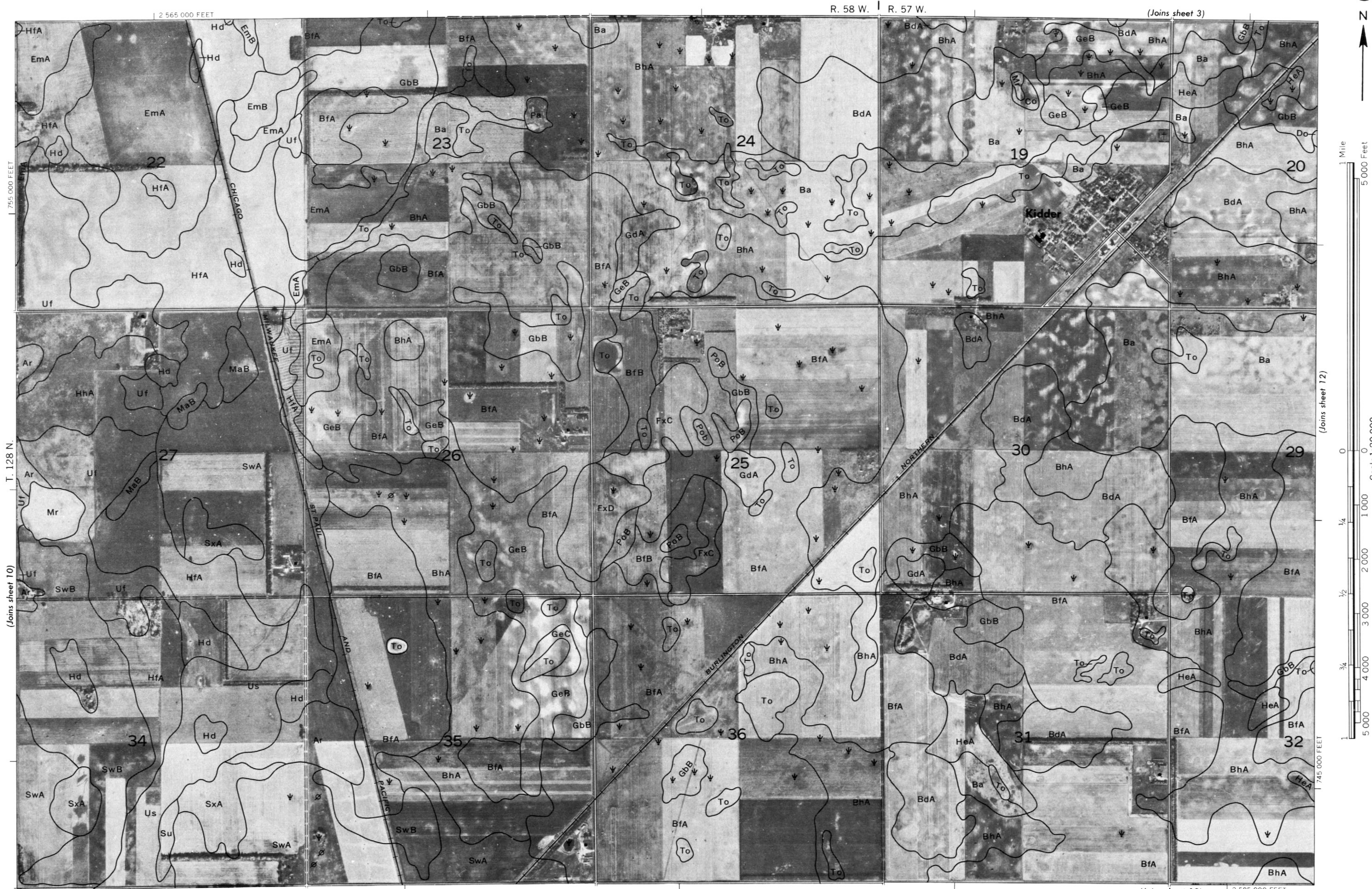
5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000


N
R. 59 W.
R. 58 W.
(Joins sheet 2)
2 560 000 FEET
755 000 FEET
T. 128 N.
(Joins sheet 11)
(Joins sheet 9)
745 000 FEET
2 540 000 FEET
(Joins sheet 18)
1 Mile
5 000 Feet
Scale 1:20 000
DAYTON
CROW CREEK
DITCH
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
EmB
BfA
SwB
Mr
Hd
Uf
Su
Ar
Ha
HhA
MaB
HvB2
EmA
HfA
Pa
EnC
HeA
To
SwA
AbA
Ba
Pm
GbB
PoB
BhA
BkE
MaD
Us


N
(Joins sheet 3)
(Joins sheet 12)
(Joins sheet 19)
(Joins sheet 10)
R. 58 W.
R. 57 W.
T. 128 N.
2 565 000 FEET
755 000 FEET
745 000 FEET
2 585 000 FEET
Kidder
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC
BURLINGTON
NORTHERN
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 Mile
5 000 Feet
Scale 1:20 000

N

R. 57 W.

2 605 000 FEET

(Joins sheet 4)

Pleasant Valley Church

Wild Rice Creek

White Lake

WHITE LAKE STATE GAME REFUGE

WATER

1 Mile 5 000 Feet

Scale 1:20 000

0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

745 000 FEET

755 000 FEET

T. 128 N.

(Joins sheet 11)

(Joins sheet 13)

(Joins sheet 20)

2 590 000 FEET

N

2 610 000 FEET

R. 56 W.

(Joins sheet 5)

755 000 FEET

T. 128 N.

(Joins sheet 12)

(Joins sheet 14)

(Joins sheet 21)

2 630 000 FEET

745 000 FEET

Scale 1:20 000

1 Mile

5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

19 20 21 22 23

30 29 28 27 26

31 32 33 34 35

GRAVEL PIT

G.P.

Wild Rice Creek

Main Line

Gulch


N
Scale 1:20 000
1 Mile
5 000 Feet
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
2 655 000 FEET
760 000 FEET
745 000 FEET
2 635 000 FEET
R. 56 W.
R. 55 W.
R. 54 W.
T. 128 N.
(Joins sheet 6)
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 22)
TRONDHJEM CEMETERY
Slough
23
24
25
26
35
36
19
30
31
7
8
9
18
17
16
19
20
21
32

15

N

2 660 000 FEET

760 000 FEET

R. 54 W.

R. 53 W.

(Joins sheet 7)

(Joins sheet 16)

(Joins sheet 14)

T. 128 N.

(Joins sheet 23)

2 680 000 FEET

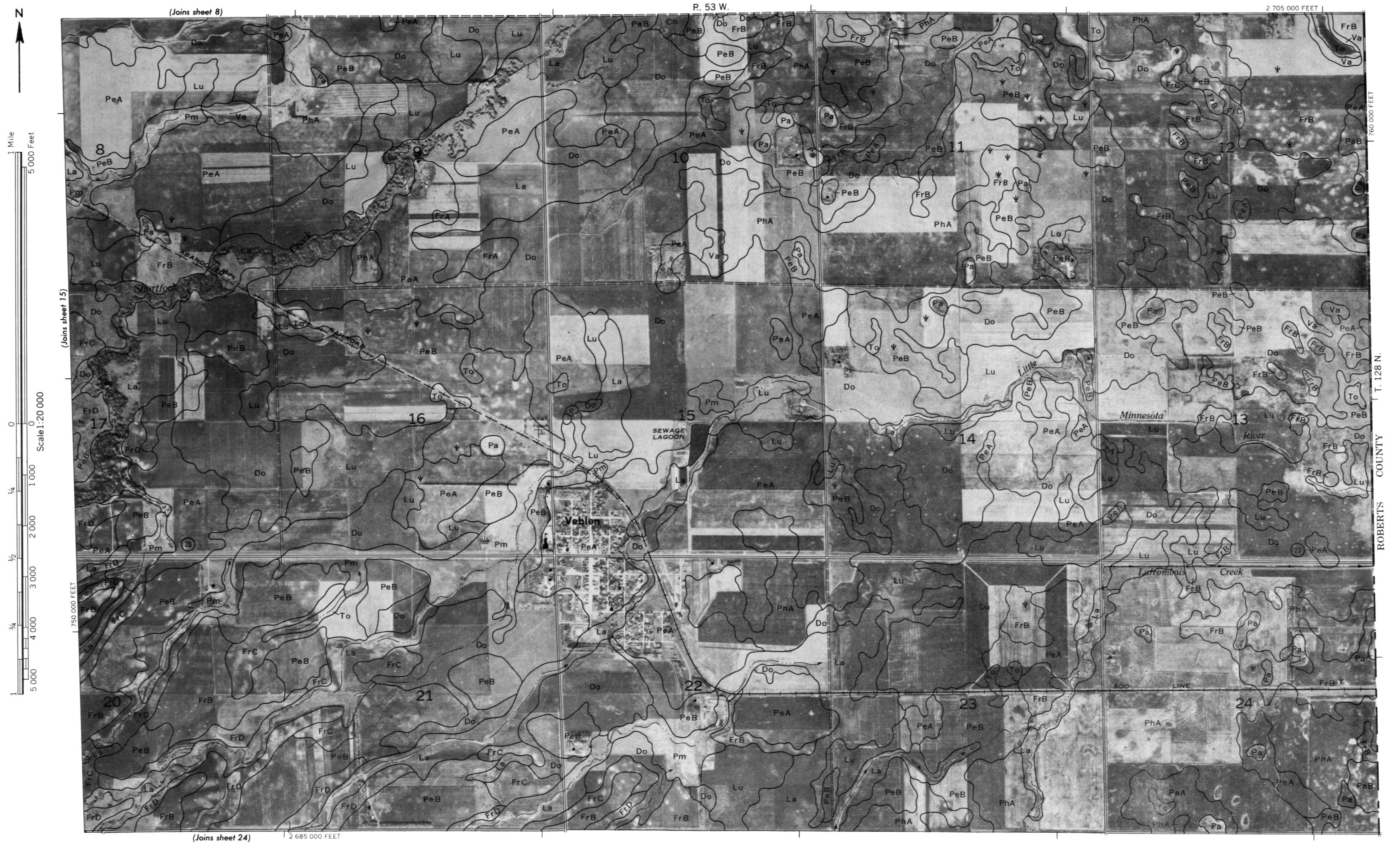
750 000 FEET

1 Mile 5 000 Feet

Scale 1:20 000

0 0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

MARSHALL COUNTY, SOUTH DAKOTA — SHEET NUMBER 16



N

2 520 000 FEET

R. 59 W.

(Joins sheet 9)

740 000 FEET

COUNTY

BROWN

T. 127 N.

730 000 FEET

(Joins sheet 18)

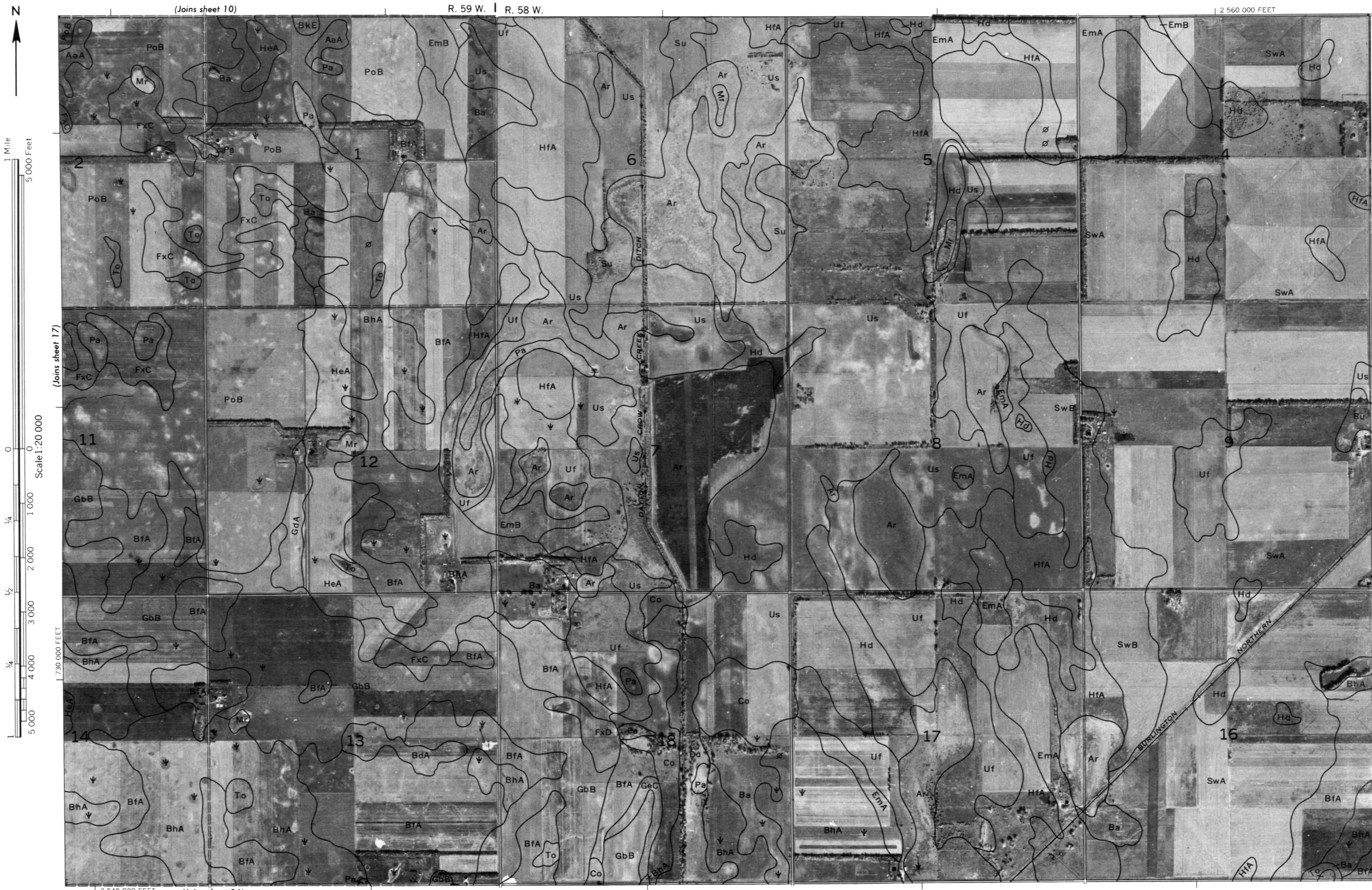
2 535 000 FEET

(Joins sheet 25)

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000


18
N
(Joins sheet 10)
R. 59 W.
R. 58 W.
2 560 000 FEET
740 000 FEET
T. 127 N.
(Joins sheet 19)
(Joins sheet 17)
(Joins sheet 26)
2 540 000 FEET
730 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000
DITCH
CROW CREEK
DAYTON
BURLINGTON NORTHERN
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

N

2 565 000 FEET

740 000 FEET

R. 58 W.

R. 57 W.

(Joins sheet 11)

T. 127 N.

(Joins sheet 18)

(Joins sheet 20)

CHICAGO NORTHERN

MILWAUKEE

BURLINGTON

ST PAUL

PACIFIC

BRITTON MUNICIPAL AIRPORT

WATER

1 Mile 5 000 Feet

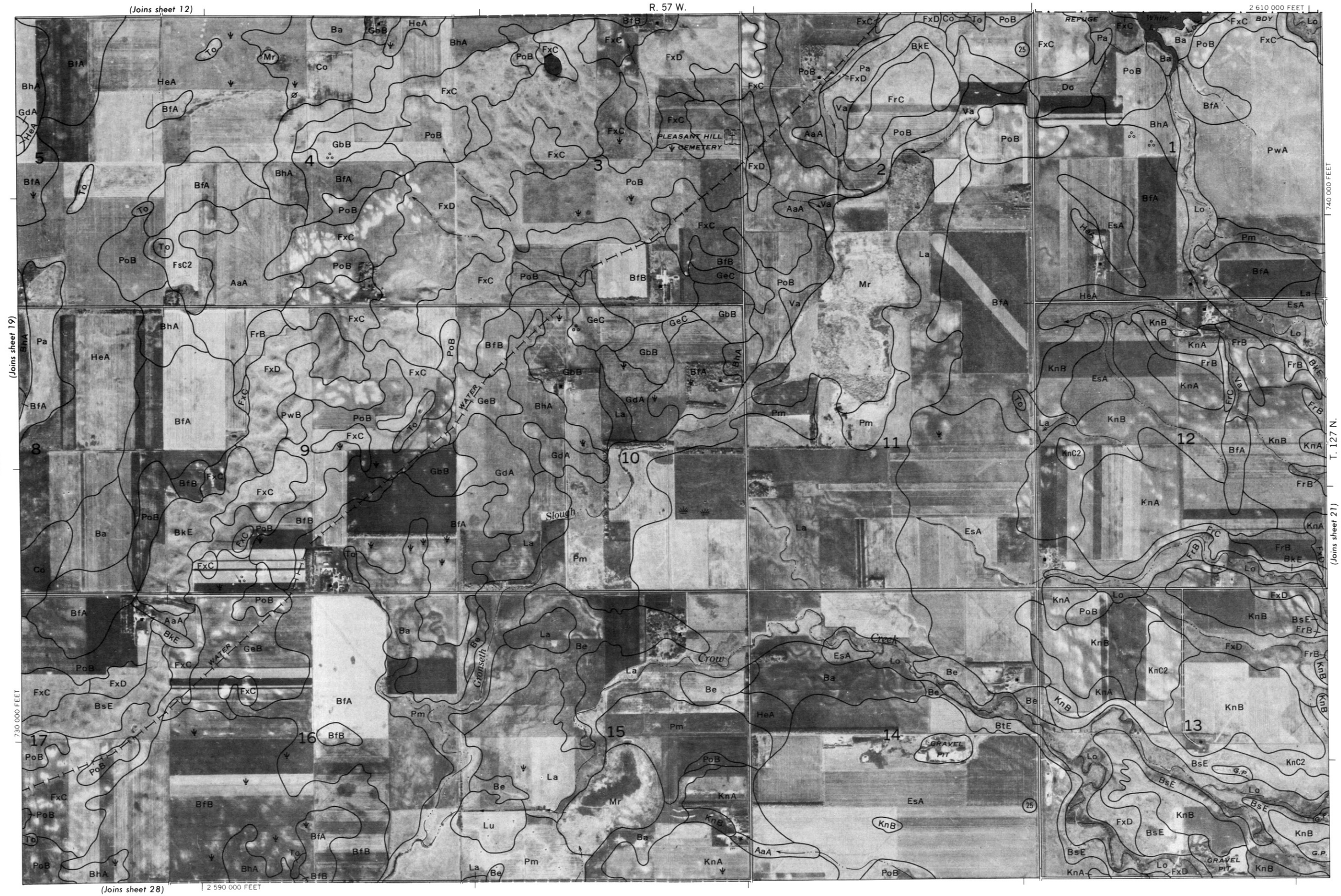
Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

730 000 FEET

(Joins sheet 27)

2 585 000 FEET


(Joins sheet 12)
R. 57 W.
2 610 000 FEET
740 000 FEET
T. 127 N.
(Joins sheet 21)
(Joins sheet 19)
730 000 FEET
2 590 000 FEET
(Joins sheet 28)
N
1 Mile
5 000 Feet
Scale 1:20 000
PLEASANT HILL CEMETERY
REFUGE
BDY
WATER
Slough
Creek
Crow
Cronseth
GRAVEL PIT
G.P.

N

2 615 000 FEET

R. 56 W.

(Joins sheet 13)

740 000 FEET

T. 127 N.

(Joins sheet 20)

(Joins sheet 22)

730 000 FEET

2 630 000 FEET

(Joins sheet 29)

(30)

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

Wild Rice Creek

Numerous Wet Spots

GRAVEL PIT

water

N

(Joins sheet 14)

R. 56 W. | R. 55 W.

2 655 000 FEET

745 000 FEET

(Joins sheet 21)

T. 127 N.

T. 128 N.

(Joins sheet 23)

730 000 FEET

2 635 000 FEET

(Joins sheet 30)

R. 55 W. \ R. 54 W.

Scale 1:20 000

1 Mile

5 000 Feet

1 000

2 000

3 000

4 000

5 000

Numerous Wet Spots

Horseshoe Lake

Silver Lake

Pleasant Peak

High Lake

water

Lirdelle Creek

N

R. 54 W. | R. 53 W.

2 660 000 FEET

745 000 FEET

(Joins sheet 15)

(Joins sheet 24)

(Joins sheet 22)

T. 128 N. | T. 127 N.

735 000 FEET

(Joins sheet 31)

2 680 000 FEET

Numerous Wet Spots

Shortfoot Creek

Hillhead

ABANDONED RAILROAD

Abraham Lake

1 Mile 5 000 Feet

Scale 1:20 000

1 0 0 5 000

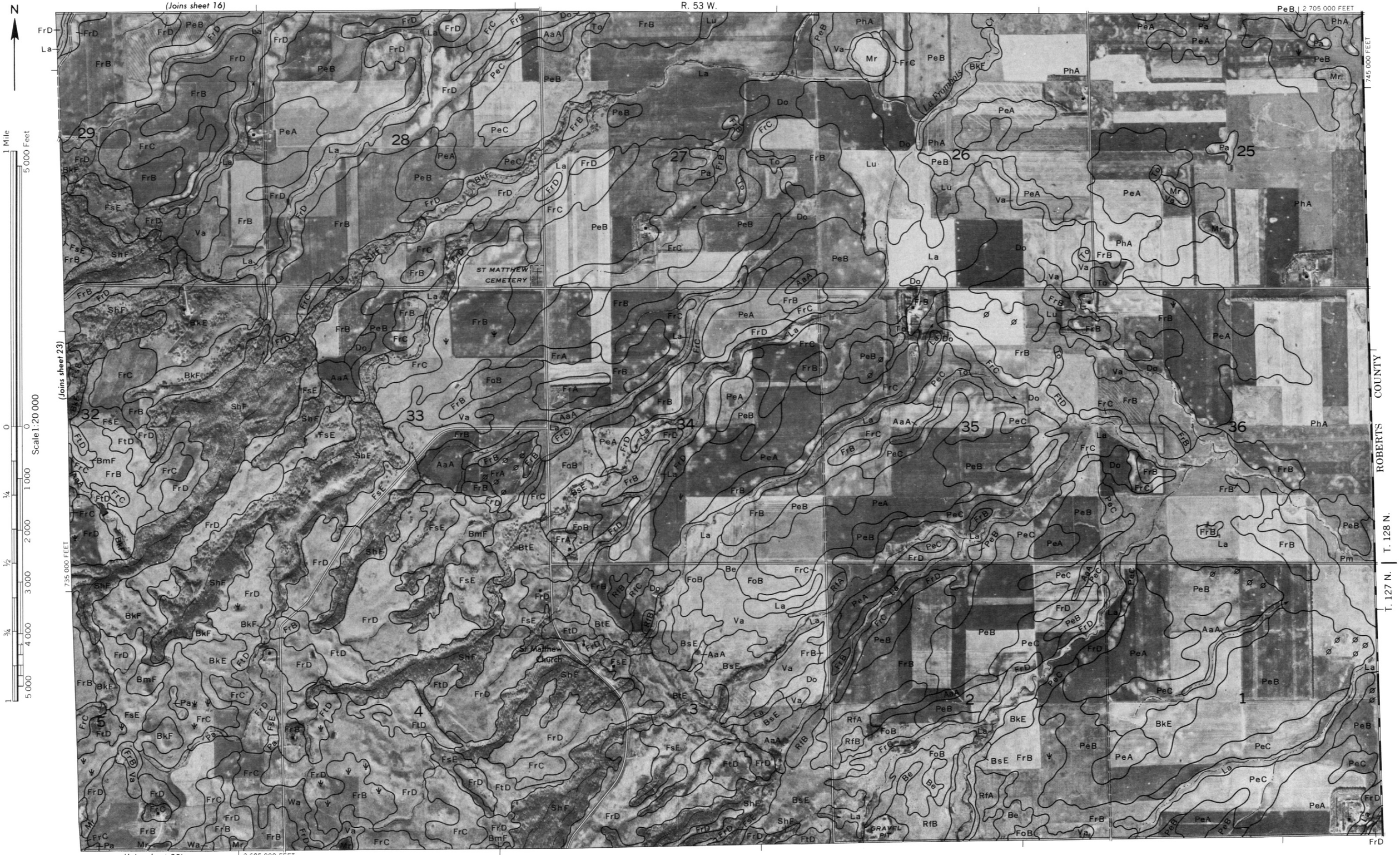
¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000


N
(Joins sheet 16)
R. 53 W.
PeB
2 705 000 FEET
745 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
735 000 FEET
(Joins sheet 23)
(Joins sheet 32)
2 685 000 FEET
ROBERTS COUNTY
T. 127 N. | T. 128 N.
ST MATTHEW CEMETERY
St Matthew Church
GRAVEL PIT
Ld Frontbois
29
28
27
26
25
32
33
34
35
36
5
4
3
2
1
7

25

N

2 520 000 FEET

R. 59 W.

(Joins sheet 17)

725 000 FEET

T. 127 N.

BROWN COUNTY

CROW CREEK

CROW CREEK DITCH

715 000 FEET

2 535 000 FEET

(Joins sheet 26)

(Joins sheet 33)

1 Mile

5 000 Feet

Scale 1:20 000

N

(Joins sheet 18)

R. 59 W. | R. 58 W.

2 560 000 FEET

725 000 FEET

T. 127 N.

(Joins sheet 25)

715 000 FEET

(Joins sheet 27)

2 540 000 FEET

(Joins sheet 34)

1 Mile

5 000 Feet

Scale 1:20 000

West Britton

BRITTON CEMETERY

DITCH

NORTHERN CROW CREEK

BURLINGTON

PATON

CROW CR DITCH

NEWPORT-WESTON DITCH

Crow Creek

23 24 19 20 21

26 25 30 29 28

35 36 31 32 33

N

R. 58 W. | R. 57 W.

2 565 000 FEET

725 000 FEET

T. 127 N.

(Joins sheet 19)

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 35)

715 000 FEET

2 585 000 FEET

Britton (county seat)

Britton Country Club

BRITTON CEMETERY

LAGOON

SEWAGE

DUMP

WATER

C. & N. W.

C. M. & ST. P.

MILWAUKEE

CHICAGO

Creek

Scale 1:20 000

1 Mile

5 000 Feet

N

(Joins sheet 20)

R. 57 W.

2 610 000 FEET

725 000 FEET

(Joins sheet 27)

715 000 FEET

2 590 000 FEET

(Joins sheet 36)

(Joins sheet 29)

T. 127 N.

1 Mile

5 000 Feet

Scale 1:20 000

20 21 22 23 24

29 28 27 26 25

32 33 34 35 36

Creek

Crow

Oak Gulch

GRAVEL PIT

G.P.

N

2 615 000 FEET

R. 56 W.

(Joins sheet 21)

725 000 FEET

T. 127 N.

(Joins sheet 30)

(Joins sheet 28)

(Joins sheet 37)

2 630 000 FEET

715 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

Numerous Wet Spots

Crow Creek

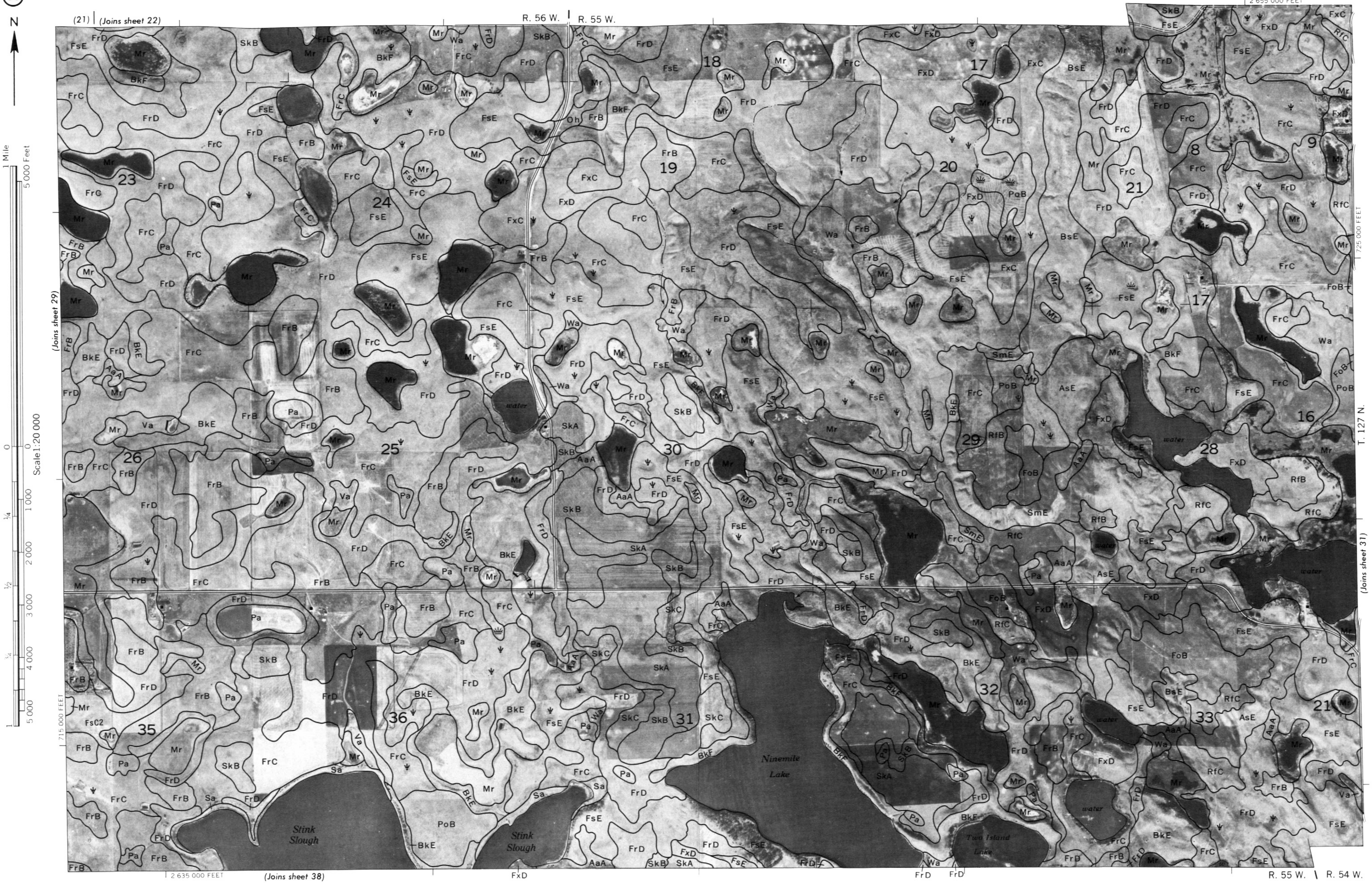
Crow Creek

Black Slough

water

19 20 21 22 23 26 27 28 29 30 31 32 33 34 35

MARSHALL COUNTY, SOUTH DAKOTA — SHEET NUMBER 30



N

R. 54 W. | R. 53 W.

2 660 000 FEET

725 000 FEET

T. 127 N.

(Joins sheet 23)

(Joins sheet 32)

(Joins sheet 30)

(Joins sheet 39)

715 000 FEET

2 680 000 FEET

Numerous Wet Spots

Flat Lake

Cottonwood Lake

Hill Lake

Dumarce Lake

Hoop Lake

Isabelle Lake

Spirit Lake

Wise Lake

ABANDONED RAILROAD

GRAVEL PIT

Scale 1:20 000

1 Mile

5 000 Feet

N

(Joins sheet 24)

R. 53 W.

2 705 000 FEET

730 000 FEET

ROBERTS COUNTY

T. 127 N.

(Joins sheet 31)

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

715 000 FEET

2 685 000 FEET

(Joins sheet 40)

GRAVEL PIT

Hill Lake

SUMMIT LAKE

Munson Creek

Munson Creek

2 520 000 FEET

R. 59 W.

(Joins sheet 25)

710 000 FEET

BROWN COUNTY

T. 126 N.

(Joins sheet 34)

695 000 FEET

2 540 000 FEET

(Joins sheet 41)

N

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 2 000 ½ 3 000 ¾ 4 000 1 5 000

AMHERST CEMETERY

Amherst

BURLINGTON NORTHERN

6 5 4 3 2 1

7 8 9 10 11 12

18 17 16 15 14 13

EmA Uf Us Hd Ar Su Do Pa Ba HfA Co SwA EmB To SxA Mr BfA SwB HeA GbB BhA Od Oh

N

(Joins sheet 26)

R. 59 W. | R. 58 W.

2 560 000 FEET

710 000 FEET

T. 126 N.

(Joins sheet 35)

(Joins sheet 33)

695 000 FEET

2 545 000 FEET

(Joins sheet 42)

Scale 1:20 000

1 Mile

5 000 Feet

0 ¼ ½ ¾ 1

5 000 4 000 3 000 2 000 1 000 0

Crow Creek

NEWPORT-WESTON TOWNSHIP

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Ar Ba BdA BfA BhA Co Do EmA EmB ExA GbB GdA GeC HeA HfA Hd Lo Lu Mr Od Pa Su To Uf Us

R. 58 W. | R. 57 W.

N

2 565 000 FEET

710 000 FEET

T. 126 N.

(Joins sheet 27)

(Joins sheet 34)

(Joins sheet 36)

(Joins sheet 43)

2 585 000 FEET

700 000 FEET

Scale 1:20 000

1 Mile

5 000 Feet

1 000

2 000

3 000

4 000

5 000

Creek

Crow

ST PAUL AND PACIFIC

CHICAGO MILWAUKEE

N

R. 57 W.

2 610 000 FEET

710 000 FEET

700 000 FEET

2 590 000 FEET

T. 126 N.

(Joins sheet 28)

(Joins sheet 35)

(Joins sheet 37)

(Joins sheet 44)

1 Mile 5 000 Feet

0 0 Scale 1:20 000

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

1¼ 5 000

Oak Gulch

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

N

R. 56 W.

2 615 000 FEET

710 000 FEET

T. 126 N.

(Joins sheet 29)

(Joins sheet 38)

(Joins sheet 36)

(Joins sheet 45)

2 630 000 FEET

700 000 FEET

Oak Gulph

Black Slough

Numerous Wet Spots

Numerous Wet Spots

water

water

water

1 Mile

5 000 Feet

Scale 1:20 000

1 0 1/4 1/2 3/4

5 000 4 000 3 000 2 000 1 000 0

N

R. 56 W. | R. 55 W. | R. 55 W. \ R. 54 W.

(Joins sheet 30)

2 655 000 FEET

710 000 FEET

T. 126 N. | T. 127 N.

(Joins sheet 39)

(Joins sheet 37)

T. 126 N.

700 000 FEET

2 635 000 FEET

(Joins sheet 46)

Scale 1:20 000

1 Mile | 5 000 Feet

0 | 0

¼ | 1 000

½ | 2 000

¾ | 3 000

1 | 4 000

5 000

Stink Slough

Squaw Hill

Nine Mile Lake

Two Island Lake

East Slough

Sixmile Lake

Fourmile Lake

Cottonwood Lake

water

1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 28

BkE BkF BmF FrB FrC FrD FsE FxC FxD PoB PwA PwB SkA SkB SkC

Mr Pa Wa AaA Va

N

2 660 000 FEET

R. 54 W. | R. 53 W.

(Joins sheet 31)

710 000 FEET

T. 126 N. | T. 127 N.

(Joins sheet 38)

(Joins sheet 40)

Dollar Lake

Dumarce Lake

Turtlefoot Lake

Crystal Lake

Cottonwood Lake

LONG LAKE

Lake City

Simons Lake

Numerous Wet Spots

RAILROAD

ABANDONED

28 27 26 25 30 29 33 34 35 36 31 32 10 15 4 3 2 1 6 5

(Joins sheet 47)

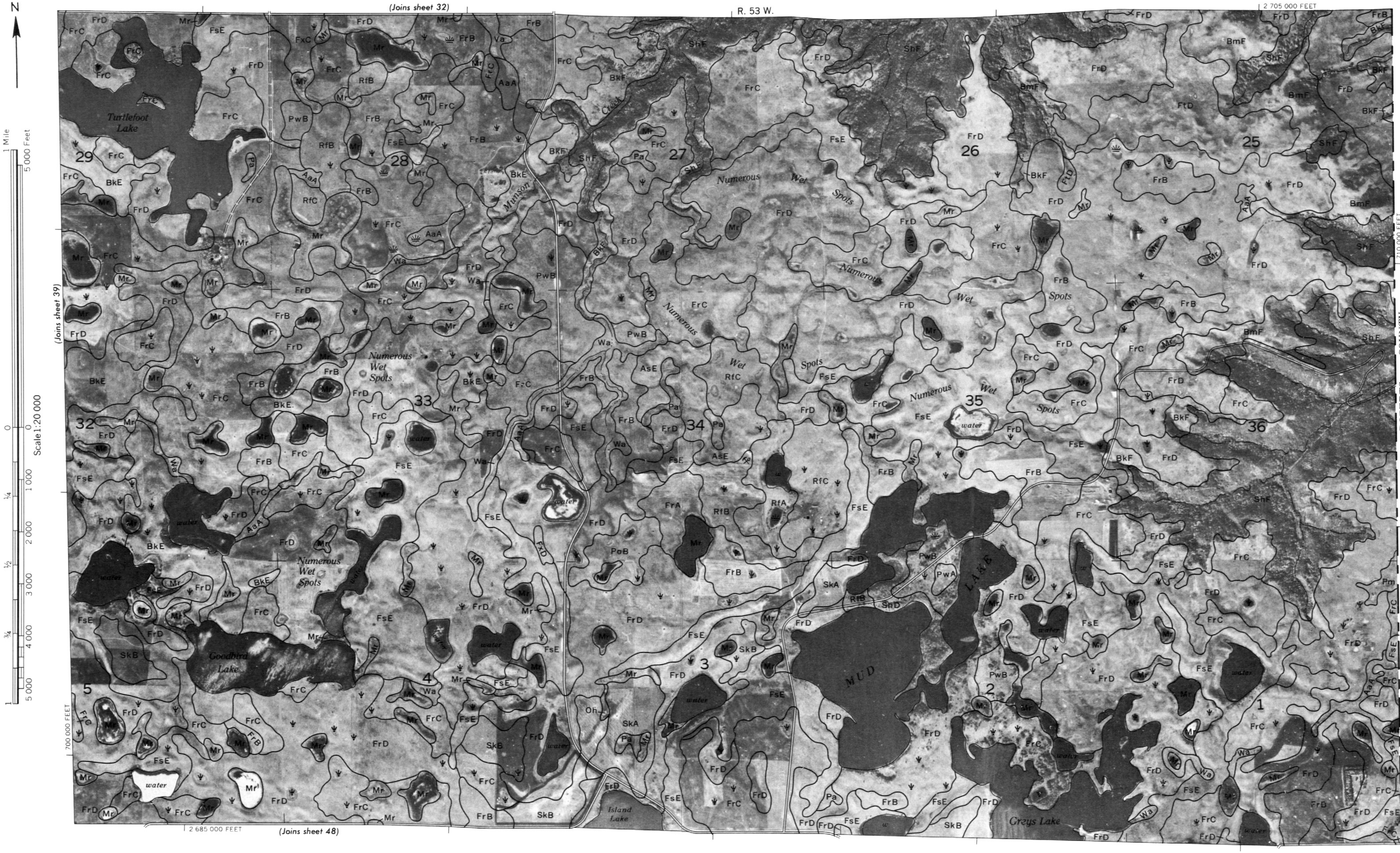
2 680 000 FEET

R. 55 W. \ R. 54 W.

1 Mile

5 000 Feet

Scale 1:20 000


N
(Joins sheet 32)
R. 53 W.
2 705 000 FEET
(Joins sheet 39)
(Joins sheet 48)
2 685 000 FEET
700 000 FEET
710 000 FEET
ROBERTS COUNTY
T. 127 N.
T. 126 N.
Scale 1:20 000
1 Mile
5 000 Feet
Turtlefoot Lake
Goodbird Lake
Island Lake
Greys Lake
MUD LAKE
Munson Creek
Numerous Wet Spots
water
29
28
27
26
25
32
33
34
35
36
5
4
3
2
1

2 520 000 FEET

R. 59 W.

(Joins sheet 33)

690 000 FEET

BROWN COUNTY

T. 126 N.

NORTHERN

BURLINGTON

19 20 21 22 23

30 29 28 27 26

31 32 33 34 35

(Joins sheet 42)

680 000 FEET

(Joins sheet 49)

2 540 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

N

Scale 1:20 000

1 Mile 5 000 Feet

0 0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 34) R. 59 W. | R. 58 W. 2 560 000 FEET

695 000 FEET

T. 126 N.

(Joins sheet 41)

(Joins sheet 43)

680 000 FEET

(Joins sheet 50) 2 545 000 FEET

NEWPORT-WESTON DITCH

SPAIN DITCH

NEWPORT-WESTON DITCH

C M ST P AND P

23 24 19 20 21

26 25 30 29 28

35 36 31 32 33

Uf Co Do Ba Lu Pa EmB EmA BhA HeA BfA ExA AbA To Hd GbB GdA SwA GeB

N

R. 58 W. | R. 57 W.

2 565 000 FEET

695 000 FEET

(Joins sheet 35)

T. 126 N.

(Joins sheet 42)

(Joins sheet 44)

680 000 FEET

2 585 000 FEET

(Joins sheet 51)

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 2 000 ½ 3 000 ¾ 4 000 1 5 000

Spain

ST PAUL

PACIFIC AND

MILWAUKEE CHICAGO

SPAIN

DITCH

22 23 24 25 19 20

27 26 25 30 29

34 35 36 31 32

N

(Joins sheet 36)

R. 57 W.

2 610 000 FEET

695 000 FEET

T. 126 N.

(Joins sheet 45)

(Joins sheet 43)

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

680 000 FEET

2 590 000 FEET

(Joins sheet 52)

20 21 22 23 24

29 28 27 26 25

32 33 34 35 36

Numerous Wet Spots

Numerous Wet Spots

45

2 615 000 FEET

R. 56 W.

(Joins sheet 37)

695 000 FEET

T. 126 N.

(Joins sheet 44)

(Joins sheet 46)

685 000 FEET

2 630 000 FEET

(Joins sheet 53)

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

N

R. 56 W. | R. 55 W.

T. 126 N.

(Joins sheet 38)

(Joins sheet 45)

(Joins sheet 47)

(Joins sheet 54)

2 655 000 FEET

695 000 FEET

685 000 FEET

2 635 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

0 1/4 1/2 1 Mile

0 1 000 2 000 3 000 4 000 5 000

Fournile Lake

Bullhead Lake

Lost Lake

ROY LAKE

water

G.P.

N

2 660 000 FEET

695 000 FEET

R. 54 W. | R. 53 W.

(Joins sheet 39)

T. 126 N.

(Joins sheet 46)

(Joins sheet 48)

(Joins sheet 55)

685 000 FEET

2 680 000 FEET

R. 55 W. | R. 54 W.

CLEAR LAKE

ROY LAKE

Numerous Wet Spots

Simons Lake

North Red Iron Lake

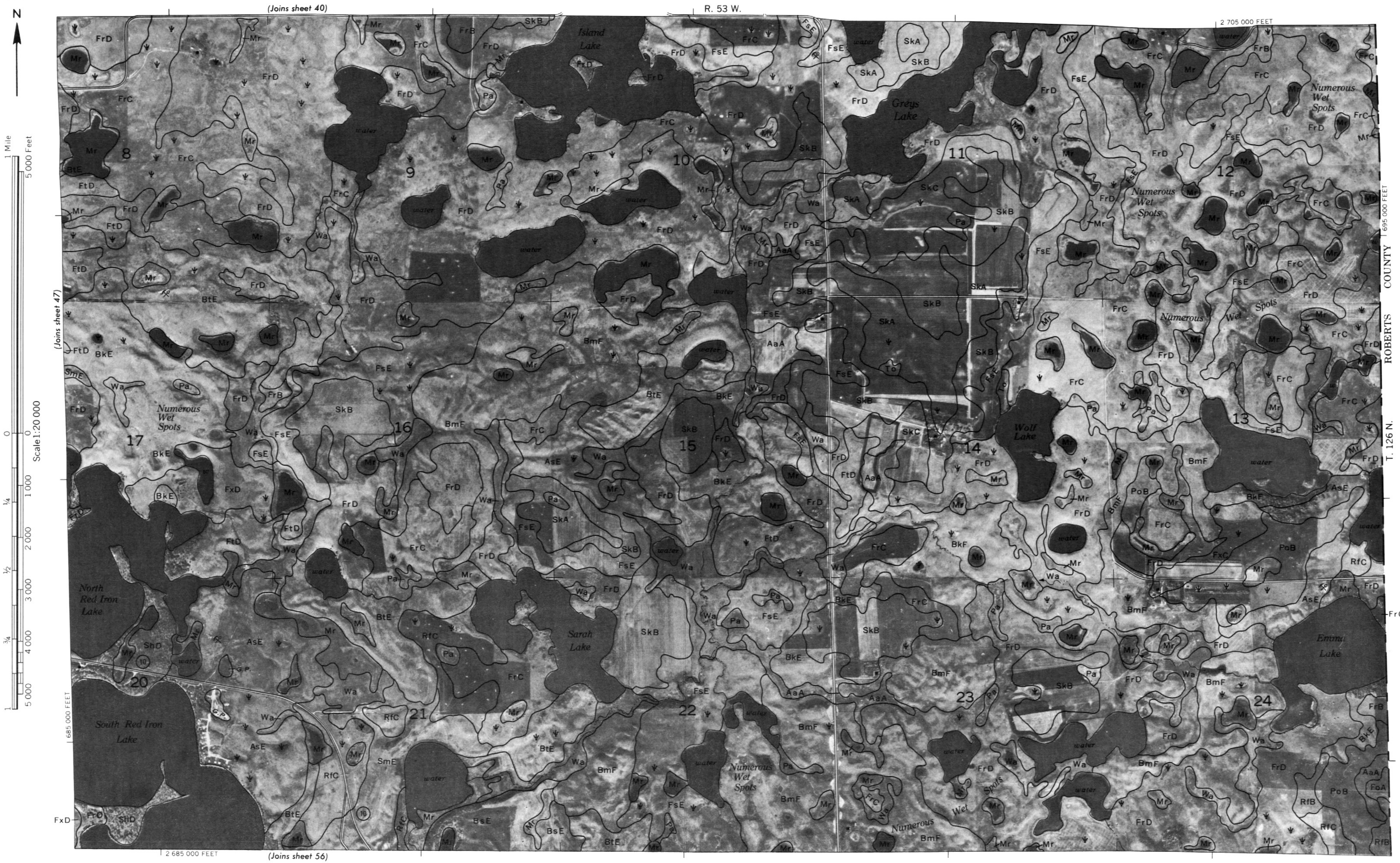
South Red Iron Lake

ABANDONED RAILROAD

Scale 1:20 000

1 Mile

5 000 Feet


N
(Joins sheet 40)
R. 53 W.
2 705 000 FEET
(Joins sheet 47)
(Joins sheet 56)
2 685 000 FEET
685 000 FEET
695 000 FEET
ROBERTS COUNTY
T. 126 N.
1 Mile
5 000 Feet
Scale 1:20 000
Island Lake
Greys Lake
Wolf Lake
North Red Iron Lake
South Red Iron Lake
Sarah Lake
Emma Lake
Numerous Wet Spots
8
9
10
11
12
13
14
15
16
17
20
21
22
23
24

N

2 520 000 FEET

R. 59 W.

(Joins sheet 41)

675 000 FEET

BROWN COUNTY

T. 125 N.

(Joins sheet 50)

665 000 FEET

(Joins sheet 57)

2 540 000 FEET

1 Mile 5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1 1 000 2 000 3 000 4 000 5 000

N

1 Mile 5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 42) R. 59 W. | R. 58 W. 2 560 000 FEET

675 000 FEET

(Joins sheet 49)

665 000 FEET

(Joins sheet 58) 2 545 000 FEET

(Joins sheet 51)

T. 125 N.

DITCH

NEWPORT-WESTON

MILWAUKEE ST PAUL AND PACIFIC

CHICAGO

R. 58 W. | R. 57 W.

2 565 000 FEET

675 000 FEET

T. 125 N.

(Joins sheet 43)

(Joins sheet 50)

(Joins sheet 52)

(Joins sheet 59)

2 585 000 FEET

665 000 FEET

Hickman Lake

N

1 Mile

5 000 Feet

Scale 1:20 000

0 5 000 1/4 1 000 1/2 2 000 3/4 3 000 4 000

N

R. 57 W.

2 610 000 FEET

680 000 FEET

T. 125 N.

(Joins sheet 44)

(Joins sheet 51)

(Joins sheet 53)

(Joins sheet 60)

2 590 000 FEET

665 000 FEET

1 Mile 5 000 Feet 0

Scale 1:20 000

0 1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000

N

2 615 000 FEET

680 000 FEET

R. 56 W.

(Joins sheet 45)

T. 125 N.

(Joins sheet 52)

(Joins sheet 54)

2 630 000 FEET

(Joins sheet 61)

670 000 FEET

Mallard Slough

Two mile Lake

Horseshoe Lake

Fort Lake

Kettle Lake

Alberts Lake

FORT SISSETON STATE PARK

Rose Hill Church

1 Mile

5 000 Feet

Scale 1:20 000

N

R. 56 W. | R. 55 W.

T. 125 N.

(Joins sheet 46)

(Joins sheet 53)

(Joins sheet 55)

(Joins sheet 62)

2 655 000 FEET

680 000 FEET

670 000 FEET

2 635 000 FEET

Scale 1:20 000

1 Mile | 5 000 Feet

Kettle Lake

Cattail Lake

Cattail Lake

Cattail Lake

West Stink Lake

water

int

1 2 4 5 6 7 8 9 11 12 13 14 16 17 18

2 660 000 FEET

R. 54 W. | R. 53 W.

(Joins sheet 47)

680 000 FEET

T. 125 N.

(Joins sheet 54)

(Joins sheet 56)

T. 125 N. | T. 126 N.

670 000 FEET

West Stink Lake

East Stink Lake

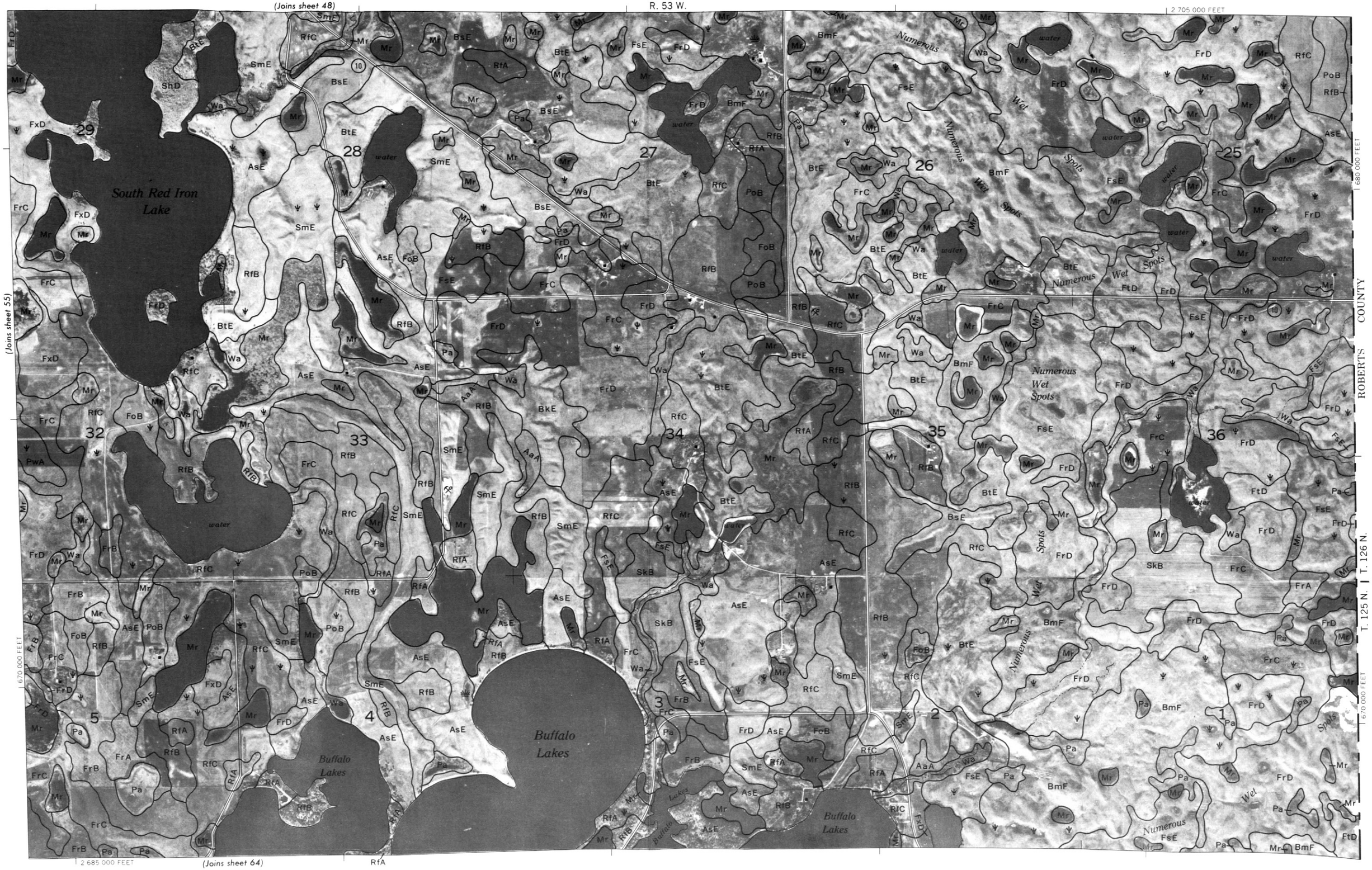
Lake Isabella

ABANDONED RAILROAD

R. 55 W. | R. 54 W.

2 680 000 FEET

(Joins sheet 63)


(Joins sheet 48)
R. 53 W.
2 705 000 FEET
680 000 FEET
670 000 FEET
2 685 000 FEET
(Joins sheet 55)
(Joins sheet 64)
ROBERTS COUNTY
T. 125 N.
T. 126 N.
South Red Iron Lake
Buffalo Lakes
water
Numerous Wet Spots
Wet Spots
Spots
29
28
27
26
25
32
33
34
35
36
5
4
3
2
1
N
1 Mile
5 000 Feet
Scale 1:20 000

57

N

2 520 000 FEET

R. 59 W.

(Joins sheet 49)

660 000 FEET

COUNTY

BROWN

T. 125 N.

(Joins sheet 58)

650 000 FEET

2 540 000 FEET

DAY COUNTY

1 Mile 5 000 Feet

Scale 1:20 000

0 5 000 1 000 2 000 3 000 4 000

¼ ½ ¾ 1

N

1 Mile 5 000 Feet

Scale 1:20 000

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 50) R. 59 W. R. 58 W.

2 560 000 FEET

660 000 FEET

650 000 FEET

(Joins sheet 57)

T. 125 N.

(Joins sheet 59)

2 545 000 FEET

DAY COUNTY

Langford

SEWAGE LAGOON

HILLSIDE CEMETERY

CHICAGO MILWAUKEE ST PAUL AND PACIFIC

59

N

R. 58 W. | R. 57 W.

2 565 000 FEET

(Joins sheet 51)

650 000 FEET

T. 125 N.

(Joins sheet 58)

(Joins sheet 60)

Highlanda Church

1 Mile 5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

650 000 FEET

2 585 000 FEET

DAY COUNTY

N

(Joins sheet 52)

R. 57 W.

2 610 000 FEET

660 000 FEET

T. 125 N.

(Joins sheet 61)

(Joins sheet 59)

650 000 FEET

2 590 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 2 000 ½ 3 000 ¾ 4 000 5 000

ROSE HILL CEMETERY

water

DAY COUNTY

2 615 000 FEET

R. 56 W.

(Joins sheet 53)

660 000 FEET

T. 125 N.

(Joins sheet 60)

(Joins sheet 62)

650 000 FEET

2 635 000 FEET

DAY COUNTY

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

N

(Joins sheet 54)

R. 56 W. | R. 55 W.

2 655 000 FEET

665 000 FEET

(Joins sheet 61)

T. 125 N.

(Joins sheet 63)

1 Mile

5 000 Feet

Scale 1:20 000

650 000 FEET

2 640 000 FEET

DAY COUNTY

Cattail Lake

Eden

RAILROAD ABANDONED

water

23 24 19 20 21

25 30 29 28

26 31 32 33

35 36

N

2 660 000 FEET

665 000 FEET

R. 54 W. | R. 53 W.

(Joins sheet 55)

(Joins sheet 64)

T. 125 N.

(Joins sheet 62)

Eden

Piyas Lake

Numerous Wet Spots

655 000 FEET

2 680 000 FEET

(Joins sheet 65)

DAY COUNTY

R. 55 W. | R. 54 W.

1 Mile

5 000 Feet

Scale 1:20 000

N

(Joins sheet 56) RfC

R. 53 W.

2 705 000 FEET

665 000 FEET

T. 125 N.

ROBERTS COUNTY

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

655 000 FEET

(Joins sheet 63)

2 685 000 FEET

(Joins sheet 66)

BUFFALO LAKES

Buffalo Lakes

Buffalo Lakes Church

PIYAS LAKE

Martha Lake

Numerous Wet Spots

water

8 9 10 11 12 13 14 15 16 17 20 21 22 23 24


2 660 000 FEET
650 000 FEET
R. 54 W.
R. 53 W.
(Joins sheet 63)
T. 125 N.
(Joins sheet 66)
DAY COUNTY
DAY COUNTY
Lake
Piyas
25
29
30
31
32
36
Pa
FxC
Mr
RfA
RfB
FxD
Sa
FoA
AsE
PoB
Va
BkE
FsE
RfC
FoB
Wa
FrD
To
SmE
2 685 000 FEET
640 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20 000
0
1 000
2 000
3 000
4 000
5 000

N

(Joins sheet 64)

R. 53 W.

2 705 000 FEET

650 000 FEET

ROBERTS COUNTY

T. 125 N.

(Joins sheet 65)

640 000 FEET

DAY COUNTY

2 690 000 FEET

Scale 1:20 000

1 Mile 5 000 Feet

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

Piyas Lake

26 25 27 28 29 30 31 32 33 34 35 36

Numerous Wet Spots